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MILITARY HANDBOOK

DEPARTMENT OF DEFENSE COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT (CALS) PROGRAM IMPLEMENTATION GUIDE

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DEPARTMENT OF DEFENSE
WASHINGTON, D.C. 20301

Department of Defense Computer-aided Acquisition and Logistic Support (CALS) Program Implementation Guide

1. This military handbook was developed by the Department of Defense with the assistance of the military departments, federal agencies, and industry.

2. This handbook provides information and guidance to personnel responsible for the acquisition and use of weapon system technical data. Its purpose is to assist in the transition from paper-intensive processes to digital data delivery and access. It also supports the structuring of contract requirements to achieve integration of various contractor automated capabilities for design, manufacturing, and logistic support.

3. Beneficial comments (recommendations, additions, deletions) and any pertinent data that may be of use in improving this document should be addressed to: Office of the Secretary of Defense, CALS Policy Office, DASD(S)CALS, Pentagon, Room 2B322, Washington, D.C. 20301-8000 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

Computer-aided Acquisition and Logistic Support (CALS) is a DoD and Industry strategy to enable, and to accelerate, the integration of digital technical information for weapon system acquisition, design, manufacture, and support. CALS will provide for an effective transition from current paper-intensive weapon system life cycle processes to the efficient use of digital information technology. The purpose of CALS is to improve industry and DoD productivity and quality, and thus improve supportability, military readiness, and combat effectiveness. The objectives of CALS are:

a. To accelerate the integration of design tools such as those for reliability and maintainability into contractor computer-aided design and engineering systems as part of a systematic approach that simultaneously addresses the product and its life cycle manufacturing and support requirements.

b. To encourage and accelerate the automation and integration of contractor processes for generating weapon system technical data in digital form.

c. To rapidly increase DoD's capabilities to receive, store, distribute, and use weapon system technical data in digital form to improve life cycle maintenance, training, and spare parts reprocurement, and other support processes.

Currently, a variety of automated systems are utilized by weapon system contractors working as a production team to enter, update, manage, and retrieve data from data bases associated with specific acquisition programs. Many of these systems are incompatible with one another other as well as with similar systems employed by the government to receive, store, process, and use delivered technical data. The functional capabilities supported by these diverse systems vary greatly. Data created in one functional process is often manually re-entered or re-created in subsequent functional processes, thereby introducing errors and increasing costs.

The near term goals for CALS implementation are attainment of increased levels of interfaced, or integrated, functional capabilities, and specification of requirements for limited government access to contractor technical data bases, or for delivery of technical data to the government in digital form.

These specifications are designed to comply with widely accepted commercial standards developed for these purposes.

The longer term goal of CALS is integration of industry and DoD data bases to share common data in an Integrated Weapon System Data Base (IWSDB) structure that is implemented through Contractor Integrated Technical Information Systems (CITIS) and government technical information systems. Data deliverables from, or government access to, specified segments of CITIS data will be explicitly required in future contracts, developed in accordance with CALS standards and procedures. The technology to accomplish this will be incrementally implemented as it is developed and proven. DoD and industry will be implementing a mixture of current and emerging technologies throughout the 1990's.

This handbook applies to programs for acquisition and support of weapon systems and related major equipment items (including support systems) to which DoDD 5000.1, DoDI 5000.2, or DoDD 5000.39 apply. Policy guidance issued by the Deputy Secretary of Defense on August 5, 1988, (Appendix A, figure 3) requires acquisition managers to evaluate CALS capabilities in source selection decisions and to implement cost effective CALS requirements in contracts for weapon systems and related major equipment items. To aid acquisition managers in implementing this policy, this military handbook provides:

- An overview of Computer-aided Acquisition and Logistic Support.
- A summary of the various ways in which digital data can be used and the forms in which digital data can be procured or accessed.
- A set of decision criteria to apply when evaluating alternative digital data delivery and access options.
- Model contract language for contractor integration of specific functional capabilities, delivery of digital data, and government access to contractor-maintained data bases.

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1. SCOPE

1.1. **Purpose.** The purpose of this military handbook is to provide general information and detailed application guidance for contractually implementing Computer-aided Acquisition and Logistic Support (CALS) requirements in weapon system and related major equipment procurements.

1.2. **Scope.** This handbook describes functional requirements and technical standards applicable to all programs for acquisition and support of weapon systems and related major equipment items (including support systems) to which DoDD 5000.1, DoDI 5000.2, or DoDD 5000.39 apply, and for which the acquisition of technical data in digital form is required in accordance with MIL-STD-1840, MIL-STD-1388-2, and supporting military specifications. This handbook also addresses those specific functional capabilities requiring integration by the contractor to support weapon system acquisition.

2. REFERENCED DOCUMENTS

See list of references appearing in Appendix A.

3. DEFINITIONS

See list of terms and acronyms appearing in Appendix A.

4. GENERAL GUIDANCE

4.1. **Purpose.** Computer-aided Acquisition and Logistic Support (CALS) is a Department of Defense (DoD) and industry strategy to enable, and to accelerate, the integration of digital technical data in standard form for weapon system acquisition, design, manufacture, and support. The intent of CALS is to improve industry and DoD productivity and quality. This leads to improved supportability, and to increased readiness and operational effectiveness.

4.2. **Digital technical data.** A primary CALS thrust is automation and integration of the generation, delivery, and use of weapon system technical data over the weapon system's life cycle. This technical data includes the part descriptions, product specifications, and standards that the initial designer draws upon; the engineering drawings and product data used in design and manufacturing; the information needed to guide the people who operate the system in the field, or who support and maintain it at all echelons of the logistic support structure; the materials needed to train new operators, maintainers and other technicians; and the information needed for reprocurement, remanufacturing, modification, and feedback to industry for future design. CALS has published technical standards which enable either delivery of this information in digital form or government access to contractor-maintained technical data bases. A more complete discussion of CALS is found in Appendix A.

4.3. **CALS requirements in weapon system acquisition.** Policy guidance issued by the Deputy Secretary of Defense (see Appendix A, figure 3) requires that plans for new weapon systems and related major equipment items include use of the CALS standards. Specifically:

a. For systems entering full scale development or production prior to September 1988, acquisition managers are required to review specific opportunities for cost savings or quality improvements that could result from changing paper deliverables to digital delivery or access using the CALS standards.

b. For systems entering development after September 1988, specific cost and schedule proposals should be obtained for: (1) integration of contractor technical information systems and processes, (2) authorized government access to contractor data bases, and (3) delivery of technical information

in digital form. These proposals shall be given significant weight for their cost and quality implications in source selection decisions. The CALS standards are to be applied for digital data deliverables.

4.4. **CALS requirements in automated data processing system acquisition.** CALS implementation involves the participation of both weapon system acquisition managers, and government and industry automated data processing system managers. Acquisitions of future computer hardware, software, and telecommunications must address CALS data interchange and access requirements. The key to supporting these requirements is an open architecture that can cost effectively support future as well as current data interchange and access needs. Although the audience for this handbook is the acquisition manager for weapon systems and related major equipment, automated data processing system managers should also be familiar with its contents. The Deputy Secretary of Defense policy guidance provided as Appendix A, figure 3, requires DoD components to program for automated systems to receive, store, distribute, and use weapon system technical data in digital form in accordance with the CALS standards.

4.5. **Application guidance.** A general framework for implementing CALS requirements is provided in Section 5.1, followed by detailed guidance on choices among digital data delivery and access alternatives. Information on digital data requirements for specific functional areas, functional integration requirements, and delivery modes is provided in Appendices B, C, and D, respectively. Other acquisition issues, including data protection and integrity, are addressed in Appendix E.

4.5.1. **Contract data requirements.** Contract Data Requirements Lists (CDRL's) and Data Item Descriptions (DID's) from previous contracts may not take advantage of automated capabilities available in current acquisition programs. Acquisition managers should identify new requirements in invitations for bid. In Requests for Proposal (RFP's), the acquisition manager should task contractors to conduct tradeoff studies to identify improved methods for data delivery or on-line access. Contractors should work with acquisition managers and contract administration activities to implement on-line access to data files, and to establish guidelines defining the actions on the part of the contractor and government that constitute delivery and acceptance of data which may remain resident at the contractor's facility. Contractors should also identify redundant data deliverables or multiple reports which can be produced from a single data file. Contractors should propose implementation of alternate delivery

methods: for example, by proposing delivery of LSAR Master Files to fulfill multiple CDRL items for hard copy reports. In some cases, technical data in digital form can be acquired with existing DID's, while in other cases new DID's must be developed. Appendix B provides additional guidance.

4.5.2. **Government furnished information.** An important subset of data required to support the acquisition of weapon systems is generated by the government and provided to the contractor as government furnished information. The acquisition manager should provide this information in digital form whenever possible. RFP's should specify contractor responsibilities for the integration of government furnished information with contractor-generated data in preparation of documents, processable files, or data bases for interactive access.

4.5.3. **Guidance for subcontracting.** The acquisition manager and potential prime contractors should jointly pay particular attention to data requirements that will flow down to subcontractors and suppliers. Requirements for delivery of digital data by prime contractors should reflect cost-effective delivery of sub-tier data where needed. Hard copy, microfilm, or non-standard digital data should be evaluated when life cycle costs may not support delivery of digital data in standard form by all subcontractors and suppliers, but delivery in standard digital form is the preferred mode. The mix of format requirements should be formalized and documented in block 16 (Remarks) of the CDRL (DD Form 1423) before contract award. When the mix of format requirements cannot be determined until after contract award, those requirements must be formalized as a contract modification.

4.5.4. **CALS application to small business.** Small business makes up a substantial portion of DoD contractors and subcontractors. The policy guidance by the Deputy Secretary of Defense (Appendix A, figure 3) directs special attention to opportunities and safeguards for small businesses operating in a CALS environment. Small business should not be put at a disadvantage because of limited resources for the investments needed to comply with CALS data delivery, data access, and functional integration requirements.

4.6. **Government receiving systems.** Contractor-generated digital data must be supported by government receiving systems that can access, receive, process, and distribute digital technical data using CALS specifications and standards. Government receiving systems are being established in the military departments and agencies during 1989-1995 for digital engineering drawings, technical manuals, and other technical data. Acquisition and

delivery of, or access to, this digital data must be phased to coincide with incremental upgrades to the government hardware, software, and procedures which constitute the receiving infrastructure. Where appropriate, the acquisition manager must consider the status of the receiving infrastructure within the acquiring Service, other Services, and the Defense Logistics Agency. Service and Defense Logistics Agency CALS offices listed in Appendix A can provide status information and additional guidance on time phasing.

4.7. **Functional capabilities.** The functional capabilities described in Appendix C constitute an evolutionary program to achieve functional integration within contractor processes and the supporting CITIS. The acquisition manager should apply the general guidance of Appendix C in the preparation of solicitation documents and resulting contracts. The acquisition manager may tailor the detailed requirements as necessary to support the acquisition strategy selected for the weapon system.

4.8. **Data protection and integrity.** DoD policies and acquisition regulations regarding data protection and integrity in the paper-based environment also apply to the CALS digital environment. Control of the system, data base, and associated data maintenance and configuration control responsibilities are important issues. These issues require consideration in the design of both Contractor Integrated Technical Information Systems (CITIS) and government technical information systems. This includes restricted access/change procedures, audit trails, and electronic marking of digital deliverables where appropriate. Aa an early contractual task, acquisition managers should require the contractor to provide a detailed plan that describes the procedures and specifications to be used in the integration, digital exchange, and sharing of data with the government and other contractors, including satisfactory security requirements. Government technical information system managers must share with CITIS managers responsibility for protection of classified, proprietary, or otherwise sensitive information (see Appendix E).

5. DETAILED GUIDANCE

5.1. **Acquisition requirements.** The integrated set of automated data processing systems and applications that will be used by the weapon system contractor team to enter, update, manage, and retrieve data from specific weapon system technical data base(s) is called the Contractor Integrated Technical Information System (CITIS). The CITIS provides the automated data processing capability used by the contractor(s) to accomplish weapon system design, manufacture, and support processes. To take advantage of current contractor CITIS capabilities, the government acquisition manager should request contractor proposals such as those described in the following paragraphs. These contractor proposals will be evaluated for their cost and quality implications as part of the source selection process, and required under the subsequently awarded contract. This section describes contract requirements that could reasonably be expected to result from this process.

5.1.1. **General contract requirements.** The solicitation or contract should state that an objective of the acquisition is to require the contractor to generate information products from all development and production functions in an integrated information system and a shared data environment. Ideally, this integration should be achieved as part of a comprehensive concurrent engineering strategy. The integrated environment will provide for generation, storage, indexing, distribution, and delivery of technical data products, and support weapon system development and production functions and processes. The objective is to create each data element once and use it repeatedly in subsequent processes without manual re-entry. The contractor should be required to provide and adhere to a comprehensive plan for meeting this objective.

5.1.2. **Contract implementation of digital data sharing and exchange.** The contractor's CITIS should provide for the integration, digital exchange, and sharing of data with the government and associated contractor(s). CITIS data base(s) should have the capability of distinguishing among, and providing visibility and accessibility of, the following data iterations:

- Working Data - Government may be provided a read only capability for in-process review of selected initial or change data/information (using partitioned data bases or other appropriate techniques), as negotiated.

- Submitted Data - The CITIS storing data released for review and approval must provide a method for incorpor-

ation of government-proposed changes and feedback to working data files, while maintaining version control and protection against unauthorized changes.

- o Approved Data - Data that have been reviewed and approved by the government or appropriate designee and requires additional controls against unauthorized changes.

The contractor plan should provide a cost effective method of managing the CITIS such that appropriate configuration and version control of technical information is maintained, while providing current data for design, engineering analysis, manufacturing, and product support planning. The plan should address capabilities for digital demand reproduction of CAE/CAD/CIM/logistic technical data, and provide for digital exchange and integration among the logistics and other functional areas.

5.1.3. **CALS integration of Computer Aided Engineering (CAE), Computer Aided Design (CAD), and Computer Integrated Manufacturing (CIM).** The contractor should be required to provide for integration of logistics processes with CAE, CAD, and CIM processes. This includes other computer aided technologies, such as computer aided testing (CAT) and computer aided process planning (CAPP). This will assure that logistic resources are developed consistent with the configuration of the weapon system and changes thereto. Process integration should be accompanied by integration of the CITIS data elements supporting those processes. This will facilitate both integration of these processes, and configuration control of the data that supports the processes. Changes in the as-designed, as-manufactured, as-delivered, and as-supported configurations of the product can be reduced, associated technical data changes can be better controlled, and the quality of both the product and data about the product will be improved.

5.1.4. **Reliability, maintainability, and supportability.** The inclusion of CAE capability in support of reliability and maintainability (R&M) development is best accomplished by making CAE support of R&M a source selection factor. The contractor should be required to describe the intended use of computer systems to provide:

a. Automated R&M analysis procedures tightly coupled to parts libraries and to material characteristics data bases.

b. Automated R&M synthesis based on design rules incorporating lessons learned from prior design experience and field use.

c. Fully characterized (tested and validated) component performance and R&M characteristics data bases.

d. Consistent data management procedures that link major design decisions affecting the R&M characteristics of the end item to the CAE software and data bases used to develop decision criteria and otherwise support the evolving configuration of the product.

e. A structure of hardware, software, and computer networks adequate to support the procedures and processes of "a" through "d" above, and to closely couple R&M specific resources (including personnel) with the rest of the design team.

5.1.5. **Integrated Logistic Support (ILS) management information.** The contractor should be required to establish an on-line direct access system capable of recording, planning, scheduling, and reporting status of ILS program requirements. This system should provide visibility of the contractor's logistic support development performance, highlighting potential problems, and should provide schedule compatibility to assure logistic support integration. The on-line system should identify change impacts on related areas of logistic support and status of retrofit program deliverables.

5.1.5.1. **Interim/phased contractor support.** The contractor should be responsible for providing on-line detailed status and accounting for interim/phased support programs as contracted. This will include status of all items inducted into a repair or maintenance program. Program status and accounting should be provided by digital means for accountability, and allow for transitioning interim support to the customer. The contractor should be required to conform with exchange standards for digital data transmissions between government and contractor activities.

5.1.5.2. **Government furnished equipment and information.** The contractor should provide for update and maintenance of the government furnished equipment portions of the weapon system based on government review, and for input of other government furnished information such as usage data and reports of installed population by operating site. Wherever possible, government furnished information should be provided in digital form for direct input into the CITIS.

5.1.6. **Supplier/vendor/subcontractor data requirements.** The contractor should provide for capture and incorporation of required supplier/vendor/subcontractor data. This should include consideration of the capability of the supplier to use neutral interchange standards to deliver digital data that is compatible with the structure of prime contractor's CITIS where appropriate. It should also include alternatives such as providing terminals and/or access to lower tier subcontractors.

5.1.7. **Logistic Support Analysis (LSA) and Logistic Support Analysis Record (LSAR).** The contract should require that data generated from the LSA program in accordance with MIL-STD-1388-1 and maintained in the LSAR in accordance with MIL-STD-1388-2 be the basis for logistics resource determinations.

a. Support equipment - The contractor should be able to respond to government agency requirements for submission in digital form of support equipment recommendation data, with provision for visibility of government changes/approvals without loss of original documentation.

b. Technical manuals/data - The contractor should provide for computer assisted generation of technical data. These data are to be derived, to the maximum extent possible, from integrated digital data files, e.g., CAD/CAE/CIM/LSAR. These data should be provided in accordance with contractually imposed functional specifications for technical manuals and other data (e.g., MIL-M-38784), the appropriate technical specifications (e.g., MIL-M-28001), in conformance with MIL-STD-1840.

c. Training and training equipment - The contractor should provide training system development with data generated and derived, to the maximum extent possible, from LSAR in accordance with MIL-STD-1388-1/-2 and from technical data in 5.1.7.b.

d. Supply support - The contractor should provide provisioning technical documentation in accordance with MIL-STD-1388-2 to facilitate automated ordering, supply management, and distribution, and should provide on-line identification of spares, repair parts, and source/maintenance/recoverability coding linked to provisioning technical documentation.

e. Facilities - The contractor should provide facilities requirements data in digital form.

5.2. **Acquisition of digital data products.** This section provides guidelines for acquisition (including both delivery and access) of weapon system engineering and integrated logistic support data in digital form. Appendix B applies this decision process to specific logistic functional areas and data products, such as technical manuals and engineering drawings. Appendix D provides additional guidance on delivery and access mode options.

5.2.1. **Acquisition considerations.** CALS is a strategy for accomplishing the transition from paper-intensive weapon system support processes to an automated and integrated form. It is not a mandate to accomplish all data acquisition digitally, regardless of other considerations. The acquisition manager must base decisions concerning acquisitions of data in digital form in any life cycle phase on acquisition policy, on technology availability, and on analysis of costs and benefits.

5.2.1.1. **Data acquisition policy.** DoD component policies and directives regarding the acquisition of digital data deliverables may govern preferred choices for specific applications and weapon system programs. These policies may address specific acquisition strategies, prime contractor/sub-tier contractor/vendor relationships and capabilities, existing Department/Agency automated data processing systems and other technical investments, future plans for automated CITIS and government systems, or other management considerations. Acquisition managers should contact the appropriate Military Department or Agency CALS Office listed in Appendix A for the most current policy directives to determine whether certain categories of data are already mandated for procurement as digital document images, processable files, or on-line access.

5.2.1.2. **Available technology.** The availability of digital data processing and telecommunications technology, and approved standards for creation, storage, transmission, data protection and integrity, etc., of data at the time of delivery or access are important criteria for acquisition decisions. The current and projected capabilities of both the contractor and DoD agencies (Service and Defense Logistics Agency) must be assessed with respect to program needs and schedules. Acquisition managers should plan to acquire digital data products rather than hard copy unless a clear case can be made that the costs will outweigh the life cycle benefits.

5.2.1.3. **Heterogeneous environment.** The rapid introduction of new technology will cause DoD and industry to operate in a mixed-mode, heterogeneous environment for many years. Some contractors with advanced capabilities will be on the leading edge of CALS IWSDB technology well before DoD is ready to put IWSDB specifi-

cations and standards in place. Many contractors are ready to implement current technology now, but will lag in the implementation of future capabilities. DoD has some near term CALS capabilities in place, but generally is not yet ready to take advantage of all of the technology that is routinely used by defense contractors. And there is still a legacy of hard copy technical data: data produced for older weapon systems and still being maintained in hard copy form, hard copy data being generated now in response to contract requirements established several years ago, and hard copy data that will be generated in parallel with the introduction of digital data technology. Government must be prepared to support all of these technology levels, and contractor teams must expect to deal with several different levels of capability among team members.

5.2.1.4. **Cost/benefit analysis.** Large productivity and quality gains are typically realized when technical data are created, stored, distributed, and used in digital form. However, initial investment expenses in automation and integration may not be offset by accrued benefits until later in the weapon system life cycle. It is important that the acquisition manager request bidders to provide comparisons of costs, cost avoidances, and benefits for alternative approaches for deliverables in their proposal. These comparisons should identify significant costs and benefits that are expected to accrue or be avoided throughout the weapon system life from both a contractor and government perspective, and the associated risks and tradeoffs. The analyses should be based upon program-specific guidance and factors provided by the government, and consider government planned capabilities to receive, distribute and use digital technical information. Results of the analyses should enable the acquisition management to assess relative risk as well as comparative costs, anticipated benefits, and return of investments associated with implementing each alternative.

Estimated costs should reflect all significant investments, transition, and operating expenses associated with the various CALS alternative approaches. Time-phased estimates of cost may consider, where applicable, categories such as:

a. Capital costs associated with new equipment required for implementation and use.

b. One-time and recurring costs for equipment operation, maintenance, and user training.

c. Contractor data creation costs.

d. Delivery and access expenses.

e. Government distribution and use costs.

f. Ongoing data update, storage and maintenance costs.

Benefits should be identified in terms of anticipated improvements in productivity and military operations.

a. In terms of productivity, identify cost savings or avoidances associated with labor, materials and equipment, as well as time reduction for the actual data creation, delivery, distribution, update, maintenance, and use of technical information. In addition, program schedule impacts should be evaluated. For example, the ability to expedite engineering change proposals within full scale development may help to reduce the overall development time, or at least reduce the risk of costly program slippages. Other benefits associated with improved functional processes and technical information should be identified (and quantified if at all possible).

b. Improvements to military operations may result due to increases in weapon system quality and performance, data accuracy, industrial and military responsiveness, readiness and sustainability. For example, fewer design problems should lead to more producible, reliable, maintainable weapon systems which ultimately effects readiness and sustainability. Improved data accuracy in technical manuals should improve the responsiveness and effectiveness of the maintenance process. Estimates of benefits should be quantified where possible.

To the extent practical, the acquisition manager should include provisions for tracking costs and benefits as they accrue during the period of contract performance. Similar systems should be established within the government in order to gain a better understanding of the actual costs and benefits associated with CALS implementations.

5.2.2. **Life cycle phases.** The weapon system's life cycle and acquisition phase are major factors in most digital data acquisition decisions. All of the potential applications for the data throughout the life cycle must be considered early in the acquisition process. The contractor must have time to put in place the automated tools to create information in the appropriate digital form for future government delivery or access. The uses of the data change as the program progresses through its acquisition phases. In the early phases (e.g., Concept Exploration and Demonstration/Validation) of a program, data volatility is a key issue, and design changes are a frequent

occurrence. Interactive access may be preferable to static reports that are quickly outdated.

5.2.2.1. **Full scale development phase.** As the program moves into full scale development, the volume of changes that require acquisition office approval rapidly increases. Interactive access could be justified to permit faster turnaround of change approvals and to help the program maintain schedule.

5.2.2.2. **Production phase.** The majority of data is delivered during the production phase. The major data acquisition issues become the volume and types of technical data being procured, and appropriate configuration management requirements. Major considerations for the acquisition manager are: how will the data be used during the operational and support phase, and how will the data be delivered and distributed throughout the logistics organizations?

5.2.2.3. **Operation and support phase.** The operation and support phase, which encompasses the longest period of time of any of the life cycle phases, sees the greatest use of old data and a continuing need for additional new data as product improvements and other changes evolve. Acquisition managers must plan carefully for the government organizations' ability to receive data in a form appropriate for its revision and use for many years downstream. Even if data was acquired through on-line access to a contractor CITIS, physical delivery of the data must be planned for at some point, such as when the weapon system finally goes out of production.

5.2.3. **Data processing categories.** The acquisition manager must consider how data will be processed in order to make good decisions on digital data requirements and format. The five defined categories of data processing typical of most weapon system programs are archive, view, annotate/excerpt, update/maintain, and process/transform. In the following discussion, the five categories have been sequenced by level of sophistication, from simple archiving to very complex information processing and transformation.

5.2.3.1. **Archive.** Archiving is the placing of data in a repository to preserve it for future use. Data may be archived in hard copy; however, future use of the data is enhanced when the data are prepared in digital form on media that allows automated retrieval. Digital data storage is also much more space efficient than any hard copy storage media. Legal questions remain on the certification of electronic records (digital data) as originals in lieu of hard copy. Use of digital deliverables may be limited for certain contract administration and accounting

functions. Data quality is usually more important than when immediate use of the data is planned, because the data may not be retrieved until after the experts who created it are no longer available to correct shortcomings. Early identification of the data repository for each life cycle phase is necessary to lay the foundation for required government and industry access for weapon system support.

5.2.3.2. **View.** View is the ability to examine a data file without the ability to change it. It is the traditional service offered by early automated systems. It normally offers the options of screen display or hard copy output from a printer. Modern workstations and terminals, however, often include a local storage device, i.e., either a hard or floppy disk drive, so that anything displayed on the screen or output to a printer or plotter can be stored locally for later retrieval at the workstation without reestablishing a connection with the host computer.

5.2.3.3. **Annotate/excerpt.** Annotate/excerpt is the ability to evaluate and highlight for future reference or to make annotations, approvals, and comments without the ability to change the original file. The extraction of relevant data for use in other documents, or for summarization purposes, is also provided at this level. The essential difference between annotate/excerpt and view is that annotations can be returned either as an overlay file or as a revised original file for processing by the host computer. This effectively allows changes to be made to the data while maintaining configuration control, although it is often cumbersome. For audit trails and version control, the acquisition manager should consider archiving these overlay and backup files, or requiring the contractor to do so through appropriate contractual tasking.

5.2.3.4. **Update/maintain.** Update/maintain is the ability to change data, either directly or through controlling software, in the active files on the host computer. An example of this data processing type would be updating the government furnished equipment portion of an assembly drawing and associated parts lists. The service life of weapon systems may extend for thirty years or more; this longevity means that the supporting data has a similarly long life during which it must be updated, maintained, and controlled.

5.2.3.5. **Process/transform.** Process/transform is the ability to extract and modify the format, composition, and structure of the data into another useable form. Process/transform entails the most complex processing of technical data. For example, computer aided design (CAD) data may be transformed into computer

integrated manufacturing (CIM) data for making spare parts on numerical control machines, or technical manual text and graphics data may be transformed into very specific troubleshooting maintenance aids for weapon system repair.

5.2.4. **Data acquisition decision process.** Figure 1 is the master template that should be used by the acquisition manager to systematically determine how data should be delivered, or made accessible, to the government by the contractor. Application guidance for use of the master template for specific functional areas is provided in Appendix B. The decision points on the template are not always exclusive and indicate a range of alternatives open to the acquisition manager. That is, selecting one option at a decision point for a particular data product within one life cycle phase does not necessarily preclude the selection of other options for that same or other data products in other life cycle phases. On each weapon system program, the delivery media and technical use for each data product, contract line item, and CDRL item must be carefully evaluated. The evaluation process involves making four sets of decisions, as shown in figure 1, and explained in the following text.

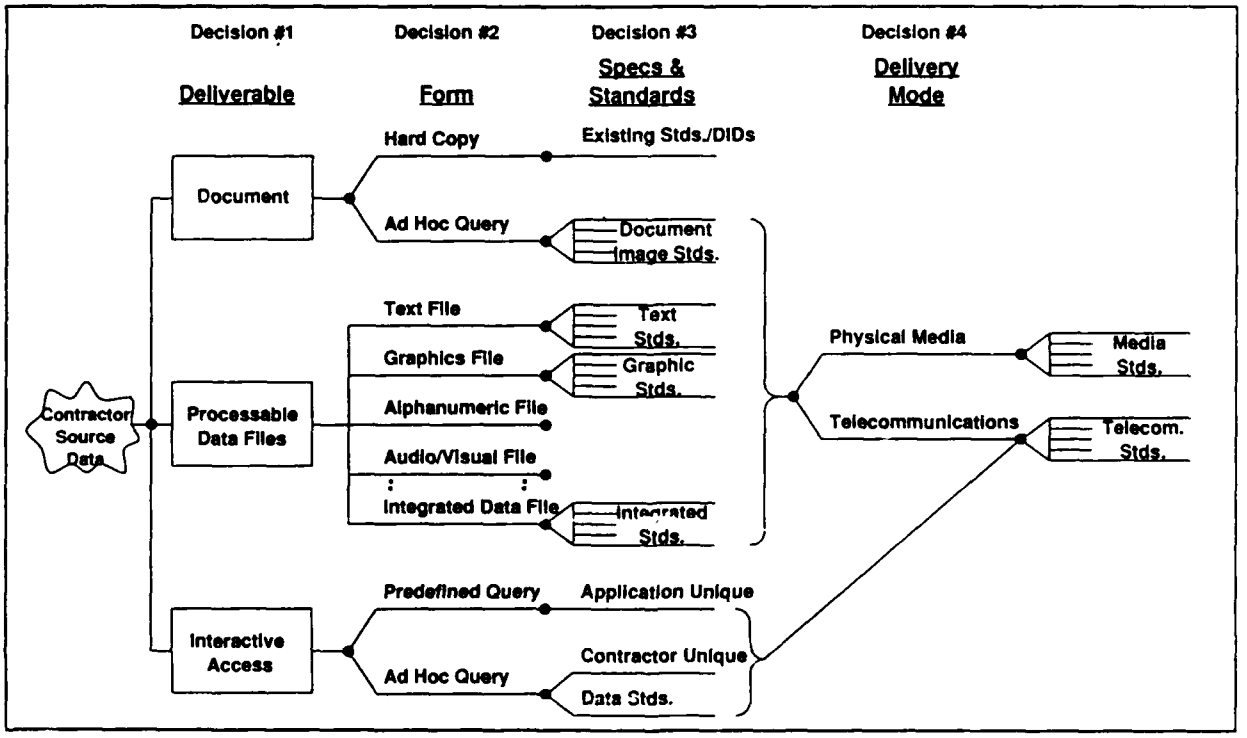

FIGURE 1. **Decision template for acquisition of digital data.**

5.2.4.1. **Decision 1 - data deliverable type.** The first decision point involves evaluation of three data deliverable types: documents, processable data files, and interactive access. These three types differ in their flexibility and in the variety of data applications they can effectively accommodate. The first option is a document (such as a drawing, manual, or report) in either hard copy or digital form. Utility of documents is much more limited than the other deliverable forms because the data has already been processed into a finished technical data product. The second option is delivery of digital data as a processable data file. Such data files can provide the source data for multiple data applications, allowing standard and custom documents to be created, as well as allowing manipulation of the data for annotate/excerpt or update/maintain purposes. The third option is interactive access, which provides an agreed-upon degree of access to the contractor's CITIS data bases. This option can provide the greatest flexibility of use, with immediate and timely data access for custom report generation and document creation, as well as on-line transactions to request transmittal of information, via physical media, as documents or processable data files. The following guidelines apply:

a. If a data product is currently ordered as hard copy, consider its digital equivalent, a digital document file.

b. If a source data deliverable is currently ordered, consider a processable data file.

c. If drafts or preliminary data products are currently ordered, consider on-line interactive access to annotate/excerpt the contractor's file to perform the review and provide comments.

5.2.4.2. **Decision 2 - data form.** The next options are the forms in which each data deliverable type can be procured.

5.2.4.2.1. **Document.** As shown at the top of figure 1, the document options are hard copy (e.g., paper and microfilm), or a digital document image (e.g., raster) file for printout and display. Both of these are static data forms. Application of this data is limited to archive, view, or annotate/excerpt only. The digital document image file option is more flexible than the hard copy option because the data can be more easily stored, transported, and managed. Neither hard copy nor digital documents can be easily modified or updated.

5.2.4.2.2. **Processable data files.** As shown in the middle of figure 1, the processable data files option provides a dynamic

form of the source data with two possibilities: separated files for text, graphics, alphanumeric, and audio/visual data; or integrated files consolidating the different data representations (text, graphics, etc.). Either can be much more easily manipulated and changed by users than can digital document images. Text files may contain free-form or structured text, depending on users and intended applications. Manuals and reports are typical examples of text files. Graphics files may contain illustrations, design data, schematics, etc., in vector format.

A technical data product delivered as digital data may contain a combination of data types and forms. The technology for converting text in hard copy or digital document image form into processable data files is rapidly maturing, and is becoming cost effective to apply in many applications. The technology for converting document graphics into processable data is also improving, but it is not yet as capable as the technology for text conversion. The choice between processable vector graphics and non-processable raster graphics is dependent on the creation and application of the data. For example, one alternative for creation of a technical manual may be the combination of a processable data file of text, together with raster document image illustrations.

Whether processable data files are to be delivered as separate or integrated files is largely dependent on technology, the functional application, and the data creation process. Technology to enable integration of separate text and graphics data files is progressing rapidly. Appropriate data standards are emerging, although they are only beginning to enter the commercial market.

5.2.4.2.3. **Interactive access.** The options shown at the bottom of figure 1 present choices for interactive access into contractors' CITIS data bases, either by predefined query methods, or by more flexible ad hoc queries. Through interactive access, the user can tailor presentation of the data to meet the user's immediate needs. As the data are needed, they can be accessed in their most current authorized version. Although this is the most powerful data type, its use is constrained by the cost of available technology, and not all contractors have an automated data processing infrastructure that provides interactive access capability. When interactive access is used, the absence of standardized access query tools among many CITIS data bases limits the ability to use the ad hoc query form.

5.2.4.3. **Decision 3 - specifications and standards.** Relevant specifications and standards must be selected to contract for the technical and functional aspects of the data. The third column

of figure 1 presents available alternatives for the three deliverable options. Here, the decision template becomes application-specific. In some cases, specifications and standards apply to a single functional application; MIL-STD-1388-2 is a standard that applies only to logistic support analysis records, for example. In other cases, a single standard can apply to several functional applications; MIL-STD-1840 is a standard that defines data organization and file layouts for technical manuals, engineering drawings, and other types of technical data.

5.2.4.3.1. **Functional and technical standards.** In a paper-based environment, functional requirements (what data to create) and technical requirements (how to organize and format that data in a report) were commonly combined in a single document. This practice has carried over into automated data processing, but now it is gradually being changed. Computer programmers and users have both found that separating functional requirements and technical requirements into separate standards makes it easier to manage changes in technology. Functional specifications and standards must be cited to govern the data creation process and, within the context of specific applications, determine the data contents and structure. Examples of functional specifications are MIL-M-38784 for technical manuals and DoD-D-1000 for engineering drawings. Technical specifications and standards must be cited to govern data structures and formats, file transfer procedures, interchange requirements, and presentation formats. Examples of technical specifications are MIL-M-28001 for technical manual text and MIL-D-28003 for technical manual vector graphics.

5.2.4.3.2. **Predefined and ad hoc queries.** Options for interactive access to contractors' data bases are shown at the bottom of the third column of figure 1. Distributed relational data base technology is so new, and is evolving so rapidly, that CITIS data bases usually have unique data organizations and unique access methods, depending on what technology the contractor has implemented, and how recently the CITIS architecture was designed.' Many different data base management systems, data base query languages, and software systems support these access methods. The options for interactive access recognize this situation. Predefined queries, the first option, retrieve and display information from the CITIS using formats that are tailored to a specific application and fixed in advance. Some latitude is provided by allowing user-defined keys to select, sequence, or summarize data. However, the information retrieval requirements are well defined in advance, and can be incorporated into the CITIS architecture even if this must be done in a CITIS-unique manner. The second option for interactive access is the ad hoc

query. By definition, an ad hoc query is application-independent. Therefore ad hoc query options are driven by technology rather than application. This leads to two alternatives for ad hoc queries: contractor-unique, and data standards. Currently, the unique data access capabilities of many contractors' CITIS may require the acquisition manager to evaluate a variety of non-standard proposals for ad hoc queries. This is the first alternative, but it is not the long-term solution.

5.2.4.3.3. **Data standards.** Data standards, the second alternative for ad hoc queries, address emerging technology and standards that govern the basic data, independent of their creation processes and their internal relationships with each subcomponent. These concepts will form the basis for development and implementation of longer term CALS capabilities. The goal of these data standards is a neutral view of data that is consistent for all applications needing the data. When this goal is achieved, data definitions, relationships, and rules for consistency and integrity will be controlled by a master data model and an active data dictionary, permitting uniform, standard access techniques for both computers and computer users. Data access methods can then be hardware and software independent, not requiring the user to be familiar with multiple, different data base access methods.

5.2.4.4. **Decision 4 - digital delivery mods.** The final options are the delivery modes in which to procure the technical data in digital form. The right side of figure 1 presents two alternatives for delivery: physical media and telecommunications. Physical media forms for delivery of digital data consist of magnetic tape, magnetic disk, and optical disk. Delivery of documents or processable data using telecommunications is not the same as interactive access, but rather is simply one-way electronic mail. Telecommunications delivery alternatives involve the selection of high-speed dedicated lines, public or private networks such as the Defense Data Network (DDN), or satellite links. The best medium of delivery is dependent on an analysis of data volumes, urgency, and frequency of use versus the cost and security of each delivery medium. With current technology, physical media transfer is generally the most cost-effective means of transferring large data files. Telecommunication networks are in increasingly widespread commercial as well as DoD use. However, CALS introduces new problems because of the volume of digital data that will be transmitted, and associated requirements for data protection and integrity. Therefore, telecommunications is currently most appropriate for interactive access or special low volume use.

5.3. **Contract deliverables.** The contract statement of work should task the contractor to prepare a CALS implementation strategy, taking into consideration the assumptions and constraints established by the acquisition manager. Supported by necessary trade studies, this strategy should enumerate and describe the framework for CALS implementation activities to be accomplished during each phase of weapon system development. It should list the technical data that will be acquired in digital form, and describes the actions to be taken by the contractor to achieve functional process integration. The implementation strategy will serve as a guide in developing contract requirements in later program development phases. It should be updated at the beginning of each program phase to define implementation plans for the upcoming phase in greater detail, resolve outstanding strategy issues, respond to strategic changes, and define appropriate contract language for the upcoming development phase.

5.4. **Data protection and integrity, data rights, and related issues.**

5.4.1. **Industry.** Contractors may choose to limit access to data documenting products, procedures, and processes for which the government or other contractors do not possess the data rights. In addition, much of the data documenting weapon systems is subject to technology transfer limitations, such as the Arms Export Control Act, that impose restrictions on free release of such data. Contractors must develop and follow procedures which ensure that digital data delivered to, or accessed by, the government are properly marked and that controls and safeguards in the digital environment provide at least the level of protection provided in the paper-based environment. Where classified information is developed or used by industry, additional oversight, programmatic controls, and special handling procedures will be imposed by the acquisition manager, who will be supported by an extensive community of security organizations. Technology and standards are still being developed to address the newly-emerging issues associated with data protection and integrity in a digital environment. Procedures for ensuring data protection and integrity are extensive; selected areas that require review during planning for the acquisition of digital information are discussed in Appendix E.

5.4.2. **Government.** The government must identify during acquisition planning the procedures that should be developed for effective management of classified, sensitive, or limited rights data. Successful implementation will require clear contractual agreement on how data will be safeguarded, both by the contractor and subsequently by the government. In addition, where govern-

ment access of a contractor data base is desired, contractors will be concerned about government access to data that have not been validated by the contractor, data the contains proprietary information, and data that is outside the scope of the contractual agreement. In such cases the government should consider acquiring access to a separate data base of validated data that has been delivered in place, until proven procedures are developed for managing government access to contractor's data systems.

5.5. **Detailed guidance for applications.** The preceding section provides general guidelines for procurement and integration of technical data in weapon system acquisition contracts. The transition from paper to digital data deliverables and digital data access requires review and revision of traditional ways of procuring data, and development of new contractual approaches. To aid the acquisition manager in accomplishing the evolutionary transition to a contractor/government shared data environment, initial CALS attention has been focused on functional areas that are large generators or users of technical data. Appendices to this handbook are provided for the following topics:

Appendix A, CALS Overview.

Appendix B, Application Guidance for Acquisition of Digital Deliverables.

Appendix C, Functional Requirements for Integration of Contractor Processes.

Appendix D, Contract Requirements for Delivery Modes.

Appendix E, Data Protection and Integrity, Data Rights, and Related Issues.

6. NOTES

6.1. **Intended use.** The purpose of this military handbook is to provide weapon system and equipment acquisition managers with general information and detailed application guidance for contractually implementing Computer-aided Acquisition and Logistic Support (CALS) requirements in weapon system and related major equipment procurements. This military handbook also describes CALS, aids in the implementation of functional integration requirements for contractors, and provides guidance to facilitate the generation, access, and delivery of digital technical information.

6.2. **Subject term (key word) listing.**

Acquisition management
CAD
CAE
CALS
CAM
Computer-aided acquisition and logistic support
Computer aided design
Computer aided engineering
Computer aided manufacturing
Computer integrated manufacturing
Computer security
Contract requirements
Contractor integrated technical information system
Concurrent engineering
Costs and benefits
Data base management
Data management
Data protection and integrity
Integrated logistic support
Life cycle
Logistic support analysis
Weapon systems

APPENDIX A

CALS OVERVIEW

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10. SCOPE

10.1. **Purpose.** This appendix provides a detailed discussion of Computer-aided Acquisition and Logistic Support.

20. REFERENCED DOCUMENTS

20.1. **Government documents.**

20.1.1. **Specifications, standards, and handbooks.** Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this handbook to the extent specified herein.

SPECIFICATIONS

MILITARY

DOD-D-1000	Drawings, Engineering and Associated Lists
MIL-D-5480	Data, Engineering and Technical Reproduction, Requirements for
MIL-D-8510	Drawing, Undimensioned, Reproducibles, Photographic and Contact, Preparation of (ASG)
MIL-M-9868	Requirements for Microfilming of Engineering Documents, 35mm
MIL-D-28000	Digital Representation for Communications of Product Data: IGES Application Subsets
MIL-M-28001	Markup Requirements and Generic Style Specification for Electronic Printed Output and Exchange of Text
MIL-R-28002	Raster Graphics Representation in Binary Format, Requirements for
MIL-D-28003	Digital Representation for Communication of Illustration Data: CGM Application Profile

MIL-M-38761	Microfilm and Microfilm Frame Desk Used for Recording Engineering Drawings and Associated Data
MIL-M-38784	Manuals, Technical: General Style and Format Requirements

(Application for copies should be addressed to the Naval Publications and Forms Center (NPFC), 5801 Tabor Avenue, Philadelphia, PA 19120 or Defense Communications Agency, DDN PMO (B613), Washington, DC 20305.)

STANDARDS

FEDERAL STANDARDS

FED-STD-1041	(FIPS PUB 100-1) Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment for Operation with Packet-Switching Data Communication Networks. (Adoption of CCITT Recommendation X.25).

FEDERAL INFORMATION PROCESSING STANDARDS

FIPS PUB 146	Government Open System Interconnection Profile (GOSIP)

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office (GPO), Washington, D.C. 20402, or the National Technical Information Service (NTIS) 5285 Port Royal Road, Springfield, VA 22161.)

MILITARY

DOD-STD-100	Engineering Drawing Practices
MIL-STD-188-114	Electrical Characteristics of Digital Interface Circuits
MIL-STD-470	Maintainability Program for Systems and Equipment
MIL-STD-499	Engineering Management
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production
MIL-STD-804	Formats and Coding of Aperture Cards

MIL-STD-1379	Military Training Programs
MIL-STD-1388-1	Logistic Support Analysis
MIL-STD-1388-2	DoD Requirements for a Logistic Support Analysis Record
MIL-STD-1777	Internet Protocol Standard
MIL-STD-1778	Transmission Control Protocol Standard
MIL-STD-1780	File Transfer Protocol
MIL-STD-1781	Simple Mail Transfer Protocol
MIL-STD-1782	TELNET Protocol Specification
MIL-STD-1840	Automated Interchange of Technical Information
MIL-STD-2165	Testability Program for Electronic Systems and Equipments

HANDBOOKS
MILITARY

MIL-HDBK-217	Reliability Prediction of Electronic Equipment

(Application for copies should be addressed to the Naval Publications and Forms Center (NPFC), 5801 Tabor Avenue, Philadelphia, PA 19120 or Defense Communications Agency, DDN PMO (B613), Washington, DC 20305.)

20.1.2. **Other government documents.** The following government documents and publications form a part of this military handbook to the extent specified herein.

FEDERAL

NSDD 145	National Policy on Telecommunications and Automated Information Systems Security

MILITARY

DDN X.25	Host Interface Specification, an implementation of CCITT Recommendation X.25

(Application for copies should be addressed to the Defense Communications Agency, ATTN: DDN PMO, Code B600, Washington, DC 20305.)

DoD-5200.28-STD	DoD Trusted Computer System Evaluation Criteria
DoD-5220.22-M	Industrial Security Manual
NCSC STD-004-85	Guidance for Applying the Department of Defense Trusted Computer System Evaluation Criteria in Specific Environments
NCSC TG-005	Trusted Network Interpretation of the Trusted Computer System Evaluation Criteria

(Application for copies should be made to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

20.2. **Other publications.** The following documents form a part of this specification to the extent specified herein. The issues of the documents that are indicated as DoD adopted shall be the issue listed in the current Department of Defense Index of Specifications and Standards (DoDISS) and the supplement thereto.

Electronic Industries Association (EIA)

EIA RS-232-C	Interface between data terminal equipment and data communication equipment employing serial binary data interchange.
EIA RS-422-A	Electrical Characteristics of Balanced Voltage Digital Interface Circuits.
EIA RS-449	General purpose 37-position and 9-position interface for data terminal equipment and data circuit-terminating equipment employing serial binary data interchange.

(Application for copies should be addressed to the Electronic Industries Association, Standard Sales, 2001 I Street, NW, Washington, D.C. 20006.)

Network Information Center (NIC)

Request for Change (RFC) 826	An Ethernet Address Resolution Protocol (IP address to media access control address translation).

(Application for copies should be addressed to the ARPANET Network Information Center; SRI International, Menlo Park, CA 94025.)

20.3. **Order of precedence.** In the event of a conflict between the text of this handbook and the references cited herein, the text of this handbook shall take precedence.

30. DEFINITIONS

30.1. **Acquisition manager.** The system/equipment program manager, the program manager's staff, and other DoD officials responsible for determining contract requirements for the generation, acquisition, and use of weapon system/equipment technical data, and having acquisition authority for weapon systems and equipment.

30.2. **CALS Core Requirement.** The set of documents that defines the environment necessary for Computer-aided Acquisition and Logistic Support (CALS) to function. These documents fall into three basic categories: functional standards, technical standards, and data standards.

30.2.1. **Functional standard.** A document that establishes and defines requirements for management, design processes, procedures, practices, methods, and data applicable to the creation of data products.

30.2.2. **Technical standard.** A standard that controls the medium or process of exchanging data between a sending and a receiving system. Data exchange is defined in terms of presentation formats and transformations of those presentation formats. Technical standards include document image standards; separate graphics, text, and alphanumeric standards; and integrated standards.

30.2.2.1. **Document image standard.** A technical standard describing the digital exchange format of a print/display file of a report or other document. (CCITT Group 4 and the proposed Standard Page Description Language are examples.)

30.2.2.2. **Graphics standard.** A technical standard describing the digital exchange format of graphics data. (CCITT Group 4 and CGM are examples.)

30.2.2.3. **Integrated standard.** A technical standard describing the exchange format of digital data which integrates text, graphics, alphanumeric, and other types of data in a single (compound) file. (ODA/ODIF is an example.)

30.2.2.4. **Text standard.** A technical standard describing the digital exchange format of textual data. (SGML is an example.)

30.2.3. **Data standard.** A specific set of data entities, relationships among data entities, and their attributes, often expressed in the form of a Data Dictionary and a set of rules

that govern data definition, data integrity, and data consistency. (The proposed PDES standard is an example.)

30.3. **Information systems.**

30.3.1. **Source system.** The computer hardware and software that will structure technical information for interchange.

30.3.2. **Destination system.** The computer hardware and software receiving transferred data.

30.3.3. **Government receiving system.** The collective term for all government agencies and offices responsible for receiving, processing, reviewing, or approving technical data ordered on government contracts, including the destination system.

30.3.4. **Integrated Weapon System Data Base (IWSDB).** The logical collection of shared data for a specific weapon system that supports both Contractor Integrated Technical Information System (CITIS) and government technical information system users throughout the weapon system life cycle. The physical location of the data may be distributed among contractor or government automated data processing systems.

30.3.5. **Technical information systems.** The generic term for the enterprise network of existing and augmented automated data processing systems used by government and contractors for management of technical information in support of the design, manufacture, and logistic processes for products such as weapon systems and related major equipment items.

30.3.5.1. **Contractor Integrated Technical Information System (CITIS).** The collection of automated data processing systems and applications used by the contractors (i.e., the prime(s) and all subcontractors) to enter, update, manage, retrieve, and distribute technical data from a specific Integrated Weapon System Data Base.

30.3.5.2. **Government Technical Information Systems.** The collection of automated data processing systems and applications used by government agencies and offices to enter, update, manage, retrieve, and distribute technical data from a specific Integrated Weapon System Data Base.

30.4. **Technical data.** Information including CAD data, CAE data, CIM data, configuration management data, group technology data, process planning and control data, engineering design data, bill of materials data, inventory data, and technical publications data.

30.4.1. **Product data.** All data elements necessary to define the geometry, the function, and the behavior of a piece part or an assembly of parts over its entire lifespan. The term includes all product definition data elements as well as additional logistics elements for reliability and maintainability.

30.4.2. **Product definition data.** The totality of data elements required to completely define a product. Product definition data include geometry, topology, relationship, tolerances, attributes, and features necessary to completely define a component part or an assembly of parts for the purposes of design, analysis, manufacture, test, and inspection.

30.4.3. **Product data exchange specification (PDES).** Proposed standard for communicating a complete product model with sufficient information content so as to be interpretable directly by advanced CAD/CIM applications such as generative process planning and CAD directed inspection.

30.4.4. **Engineering data.** Any data, either government, contractor, or vendor, that contain authoritative engineering definition or guidance on material, items, equipment system practices, methods, and processes relating to the design, manufacture, acquisition, test, inspection, or maintenance of items or services. Engineering data includes the following: drawings, associated lists, contractor or vendor specifications, standards, documents referenced on drawing lists, revision authorization documents, engineering change orders, government or industry associated specifications and standards, and other related documents.

30.5. **Contract data deliverables and access.**

30.5.1. **Document.** A set of text or graphics technical data organized and formatted for direct human interpretation. A document can be delivered as printed pages or digitally in the form of composed page images. Technical data supplied in document form are not intended for subsequent processing or transformation.

30.5.2. **Document Image File.** A file of composed page images in digital form. Examples are raster image files and page description language files.

30.5.3. **Processable Data File.** Alphanumeric, text, graphics or integrated data files organized and formatted so that an automated data processing system can further structure or restructure the data in a variety of ways. Unlike document image files, processable data files may contain information that is directly machine-interpretable. Processable data files provide

additional flexibility of use because they consist of the digital source data from which documents of varying types can be produced.

30.5.4. **Interactive Access.** The ability to access authorized portions of the source data in a CITIS or government system via on-line telecommunications data transfers in real or near-real time using various types of queries. Interactive access can be used to generate documents, processable data files, or both. Data processing categories for interactive access cover the entire range from view only to the full capability of down-loading data for subsequent processing and transformation purposes. Interactive access also includes on-line transactions which request transmittal of information via physical media as documents or processable files.

30.6. **File types.**

30.6.1. **Alphanumeric File.** A data file containing structured numeric or alphanumeric fields. Data base files are alphanumeric files.

30.6.2. **Text file.** A file which uses the American Standard Code for Information Interchange (ASCII) or similar system to represent the text of a document. Data within a text file are delineated as human readable words, sentences, and paragraphs rather than data elements.

30.6.3. **Text/Graphics integration.** The necessary indexing and linkages between a computer readable text file and computer readable graphics file so that they can both be output or updated as a single, apparently continuous, file.

30.7. **Acronyms and abbreviations.** The acronyms and abbreviations used in this military handbook are defined as follows:

ANSI - American National Standards Institute
ASCII - American Standard Code for Information Interchange
CAD - Computer Aided Design
CAE - Computer Aided Engineering
CALS - Computer-aided Acquisition and Logistic Support
CCITT - International Consultative Committee on Telegraphy and Telephony
CD-ROM - Compact Disk-Read Only Memory
CDRL - Contract Data Requirements List
CGM - Computer Graphics Metafile
CIM - Computer Integrated Manufacturing
CITIS - Contractor Integrated Technical Information System
DDN - Defense Data Network

DID	-	Data Item Description
DLA	-	Defense Logistics Agency
DoD	-	Department of Defense
EDI	-	Electronic (business) Data Interchange
FIPS	-	Federal Information Processing Standard
GOSIP	-	Government Open Systems Interconnection Profile
IGES	-	Initial Graphics Exchange Specification
ILS	-	Integrated Logistic Support
IP	-	Internet Protocol
ISD	-	Instructional Systems Design
IWSDB	-	Integrated Weapon System Data Base
LAN	-	Local Area Network
LSA	-	Logistic Support Analysis
LSAR	-	Logistic Support Analysis Record
ODA/ODIF	-	Office Document Architecture / Office Document Interchange Format
OSD	-	Office of the Secretary of Defense
OSI	-	Open Systems Interconnection
PDES	-	Product Data Exchange Specification
PDL	-	Page Description Language
R&M	-	Reliability and Maintainability
RFP	-	Request for Proposal
SGML	-	Standard Generalized Markup Language
SOW	-	Statement of Work
SPDL	-	Standard Page Description Language
TCP	-	Transmission Control Protocol
TDP	-	Technical Data Package

40. OVERVIEW OF COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT (CALS)

40.1. **CALS overview.** Computer-aided Acquisition and Logistic Support (CALS) is a Department of Defense (DoD) and industry strategy to facilitate the integration of digital technical information for weapon system acquisition, design, manufacture, and support functions. The Deputy Secretary of Defense launched the DoD CALS initiative in September 1985 and established a DoD Steering Group to oversee its implementation. CALS will provide an effective transition from current paper-intensive weapon system acquisition and support processes to the efficient use of digital technical information. CALS will reduce acquisition and operating costs, shorten lead times for acquisition and logistic support, and thereby improve military readiness and combat effectiveness.

40.1.1. **CALS requirements.** Both DoD and industry are investing in automation of a variety of functional areas to achieve productivity and quality gains. Existing islands of technical data automation within DoD, between DoD and industry, and within industry must be interfaced and integrated to reduce duplicative data generation and maintenance, and to eliminate requirements for expensive hard copy output and reentry of data. CALS addresses requirements for an orderly transition from a labor and paper-intensive environment to the use of digital technical information for design, manufacturing, acquisition, and support processes.

40.1.2. **CALS strategy.** To achieve CALS benefits, a phased CALS strategy has been established by a team consisting of Office of the Secretary of Defense (OSD), the military departments, the Defense Logistics Agency (DLA) and industry. The key elements of that strategy are:

a. Standards and integration requirements. Accelerate the development and testing of standards for digital technical data interchange and integrated data base access.

b. Weapon system applications. Implement CALS standards in weapon system contracts and encourage Industry modernization and integration.

c. Technology development and demonstration. Sponsor the development and demonstration of the necessary technology for integration of technical data and processes in high risk areas.

d. DoD systems. Implement CALS standards and integration requirements in DoD planning and infrastructure modernization programs. Infrastructure is the underlying framework of organizations, systems and processes within which DoD operates.

40.2. **CALS concepts.** The CALS system of systems approach, shown in figure 2, consists of these key elements:

a. Industrial systems (i.e., design, manufacturing, and customer support).

b. Government systems, (i.e., acquisition and logistic support).

c. Interfaces between industry and government.

d. Interfaces within industry among prime contractors, subcontractors, and vendors.

Information can pass between these systems, in both directions, in the form of documents, processable data files, and interactive access to data bases.

40.2.1. **CALS standards.** Three broad groups of requirements documents constitute the CALS interchange standards shown in figure 2. They are:

a. Functional Standards. Military standards, military specifications, and Data Item Descriptions (DID's) which define functional processes, data requirements, data creation procedures, and the content and format of data products.

b. Technical Standards. Federal standards, military standards, military specifications, and other relevant conventions (including their associated DID's) for the management, formatting, and physical media or telecommunications exchange of text, graphics, alphanumerics, and other forms of digital data.

c. Data Standards. Data dictionaries that provide rules governing data element definitions, data relationships, and requirements for data integrity and consistency. The standards also include file structure definitions, index keys, and other descriptive information needed for access to data bases.

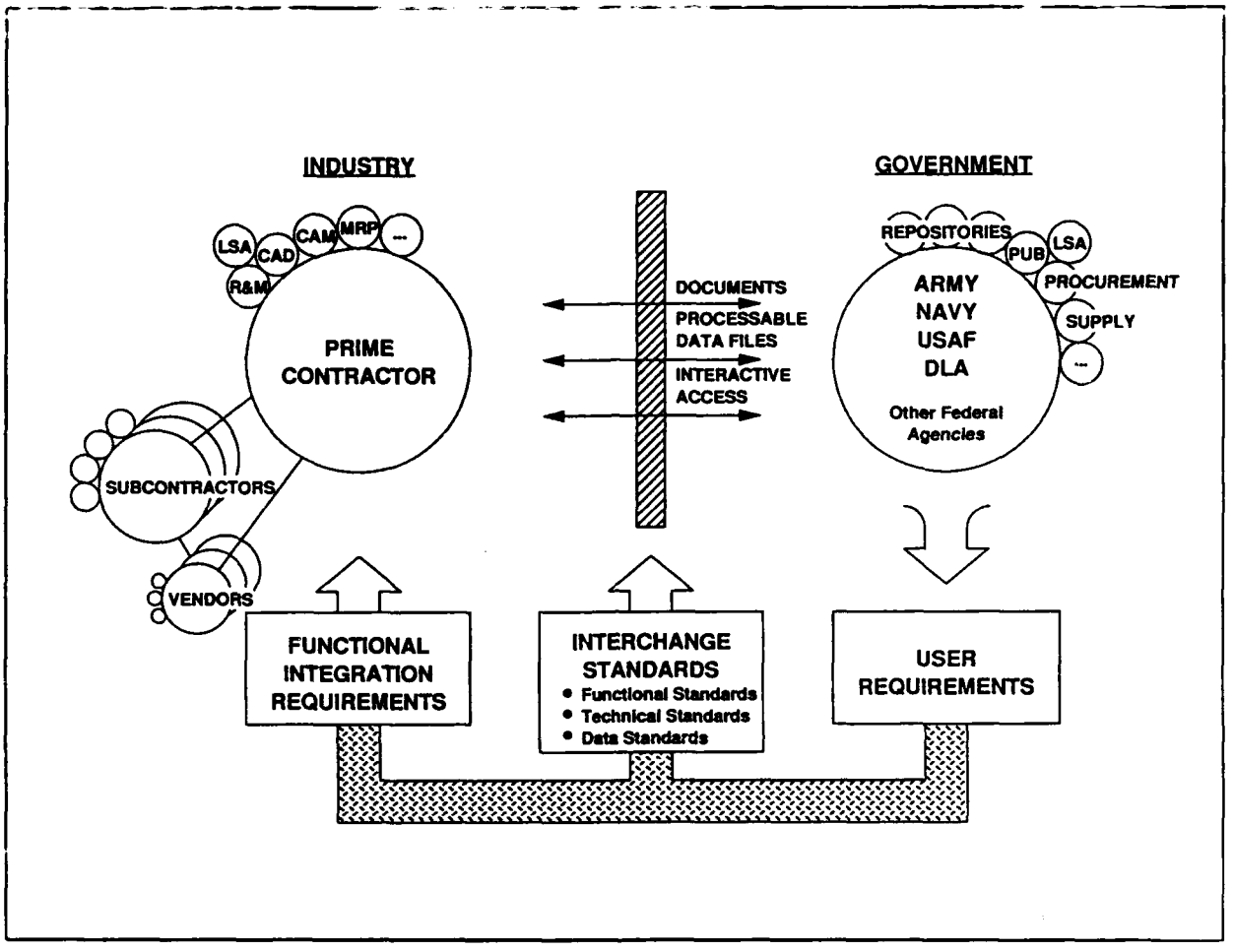


FIGURE 2. **Digital information exchange.**

40.2.2. **Functional integration requirements.** A major CALS objective is a standardized approach for integrating technical data use within a weapon system program. Functional integration requirements are contractual tasks to be used in statements of work (SOW) or incorporated in functional standards articulating the required contractor capabilities for the integration of data systems and processes. These requirements specify the integration of design, manufacture, and support processes, as well as other elements of concurrent engineering, for the performance of DoD contracts. They also establish the means by which contractors will demonstrate the capability to access and share data bases among and between functional areas. These functional requirements will eventually be incorporated in updates to appropriate military standards and specifications. The model SOW language in this handbook is provided for use pending these updates.

40.2.3. **Contractor Integrated Technical Information System (CITIS).** As CALS capabilities evolve, technical data required by the government for a single weapon system will be logically integrated (not necessarily physically integrated) into tightly coupled, controlled, and secure weapon system technical data bases, allowing access and transfer of data to those parties with proper authorization and need to know. The integrated automated data processing systems and applications that are utilized by the contractor to enter, update, manage, retrieve, and distribute data from technical data bases for a specific weapon system is called a Contractor Integrated Technical Information System (CITIS). The required functional integration of those contractor processes necessary to ensure the security, currency, and accuracy of the technical information resident in the weapon system technical data bases will be articulated and contractually specified as requirements for the contractor's CITIS. In addition to requiring integration of the contractor's internal data and processes themselves, further integration of internal contractor data and processes with the government furnished information for each weapon system is essential.

40.2.4. **Government Technical Information Systems.** The collection of automated data processing systems and applications that are utilized by the government to enter, update, manage, retrieve, and distribute data from technical data bases for a specific weapon system will exist on multiple distributed automated data processing systems. It will cross functional boundaries and may combine data from more than one DoD component to support all requests for data from a single weapon system's user community. This degree of interchange and integration will require tight control and coordination of the separate physical data bases to allow transparent support to the user. The needed control and coordination within and among the CITIS and government systems supporting a weapon system will be provided by a logical data structure called the CALS Integrated Weapon System Data Base.

40.2.5. **CITIS and government technical information system data for common items.** Technical data for subsystems or components with multiple weapon system applications must be available to users without unnecessary storage redundancy. Hence, the issues of integration and standards for data exchange and access are just as applicable horizontally across weapon systems as they are vertically within the integrated technical data infrastructure for a single weapon system.

40.2.6. **Technical data and business data.** CALS deals with technical data, which includes CAD/CAE/CIM and configuration management data, group technology and process planning/control data, engineering design and bill of materials data, inventory

data, and technical publications data. Another key aspect of information interchange in digital form deals with business transactions for ordering, shipping, and making payment for the products described by CALS technical data. Business data in digital form is addressed by DoD's electronic data interchange (EDI) program, which also implements approved national standards (ANSI X.12) and reflects a common government and industry migration to a digital commercial environment. CALS will develop EDI transaction sets for accessing and ordering technical data from remote data bases, and for enveloping technical data packages and exchanges of technical information within an enterprise network.

40.2.7. **Concurrent engineering.** Concurrent engineering is a systematic approach to creating a product design that considers all elements of the product life cycle from conception through disposal. In so doing, concurrent engineering simultaneously defines the product, its manufacturing processes, and all other required life cycle processes, such as logistic support. Concurrent engineering is not the arbitrary elimination of a phase of the existing, sequential, feed-forward engineering process, but rather the co-design of all downstream processes toward a more all encompassing, cost effective optimum. Nor does concurrent engineering entail simultaneous design of the product and execution of the production process, an approach which is demonstrably unsound. Concurrent engineering is an integrated design approach that takes into account all desired downstream characteristics during upstream phases to produce a more robust design that is tolerant of manufacturing and use variation, at less cost than sequential design. It affects all system procurement activities from Milestone 0 (concept definition and exploration) to the start of Milestone III (the end of full scale development).

There are three dominant approaches being taken by contractors today to implement elements of concurrent engineering:

a. Engineering process initiatives to improve the organizations and procedures used to develop a product, such as formation of design teams that include people from multiple disciplines.

b. Computer-based support initiatives such as improvement of computer aided design tools, leading to integration of various software applications and supporting data. This is part of a broader objective to create a data object once, and use it as a source for many functions and processes, including design synthesis and verification, production planning, and logistic support planning.

c. Use of a variety of formal methods, including the application of special purpose tools for design and production support. Examples include statistical process control, design of experiments, design for assembly, and Taguchi quality engineering.

CALS initiatives to improve technical data creation, management, and use provide an enabling environment that will accelerate the application of concurrent engineering concepts, and their consequent benefits. These benefits include the opportunity for significant reductions in product development cycles, a wide range of cost savings, and substantial improvements in product quality. Specific CALS thrusts, such as integration of reliability and maintainability (R&M) with computer aided design (CAD) and computer aided engineering (CAE) will directly contribute to application of concurrent engineering concepts.

40.2.8. **Integration of R&M with CAD and CAE.** Integration of R&M with CAD/CAE is a high leverage, high payoff CALS target which will provide significant improvements in the inherent reliability and maintainability characteristics of a weapon system's design. These gains will translate into greater operational effectiveness, and will decrease life cycle costs associated with the weapon system when deployed. Integration of R&M tools with the CAD/CAE process is a contributor to a comprehensive concurrent engineering strategy, whose objective is design optimization through integration of R&M and other domains within a cost effective engineering process. R&M integration with CAD/CAE will require changes to conventional post design analysis processes. These changes will consist primarily of the following:

a. The development of user-friendly analytical tools that are tightly coupled to the product design data base and that can be rapidly executed by the designer to provide short-cycle feedback about the effectiveness of the design approach during the design process itself.

b. The development of effective means to take advantage of lessons learned from prior design experience and field use in the form of design rules, expert systems, etc.

c. The development of fully characterized component design, performance, and reliability data in a format readily accessible by these automated tools.

For further details see Appendix C.

40.3. **CALS implementation.** CALS is organized into two overlapping phases which are characterized by the application of different levels of technology to technical data management, and by different degrees of impact on functions and processes allowed by this enabling technology. Near term implementation focuses on converting current paper flows to digital form while beginning the integration process. Longer term implementation focuses on replacing the parallel and duplicative requirements imposed by various acquisition disciplines and functions (e.g., design engineering, configuration management, integrated logistic support, test and evaluation, etc.) with requirements to develop integrated weapon system data bases that are implemented through CITIS and government technical information systems. These CALS capabilities will allow technical data sharing at the data base level, rather than at the physical file level, with multiple formats of the same data from a common, configuration-controlled source available to different users. This will include the information needed for product design, engineering analysis, manufacture, and support, and will facilitate application of a comprehensive concurrent engineering strategy by making information accessible to a variety of industry and DoD users through automated and highly integrated means. However, CALS implementation will be characterized by a heterogeneous, mixed mode environment in which initiatives at different levels of technology often will be implemented in parallel as evolving capabilities allow.

40.3.1. **Near term CALS capabilities.** Initial implementation focuses on exploiting current and near-term technology to enhance the highest impact acquisition and logistics functions; specifically, it focuses on:

a. Engineering drawings and other information used to support competitive spares procurement.

b. Technical manuals and other information used to support weapon system maintenance.

c. Logistic Support Analysis Records (LSAR's) and other information used to plan logistic support.

d. Life cycle configuration management of weapon system technical information.

e. Automated interfaces among R&M data, logistics, system engineering, and CAD.

40.3.1.1. **Near term CALS events.** In these early implementation activities, application of technical standards will permit digital data interchange in neutral format within and among DoD

components, and between DoD and industry. This interchange of technical data without resorting to paper products will result in increased accuracy and timeliness of data transfer at lower costs. Wherever possible, DoD is adopting approved national and international standards rather than creating unique DoD protocols to define this interface. From a technical perspective, CALS is applicable to equipment items at all levels of indenture, from the weapon system and weapon system platform to piece parts. However, CALS will find its most productive initial applications at the weapon system level, where the contractor and government infrastructures to use these technical standards are already in place or planned.

40.3.1.2. **Near term CALS mechanisms.** The mechanism for implementing these near term capabilities is a set of core requirements (i.e., sample contract language and technical standards) that will be used by the DoD components in near-term weapon system and data system acquisitions. The initial standards have been coordinated throughout DoD and the defense industry, and published as MIL-STD-1840, along with associated military specifications. Although it was published before CALS was established, MIL-STD-1388-2 is also considered to be one of the CALS technical standards. This handbook is a companion document to the CALS standards that provides initial CALS implementation guidance to the acquisition manager.

40.3.1.3. **CALS military specifications.** CALS technical standards are being developed and published incrementally to provide additional levels of functionality and technical capability. MIL-STD-1840 provides data interchange and file management requirements for a family of supporting military specifications. The specifications already published include MIL-D-28000, MIL-M-28001, MIL-D-28002, and MIL-R-28003 (20.1.1). As other CALS military specifications are developed, this handbook will be updated to provide necessary application guidance.

40.3.2. **Longer term CALS capabilities.** While near term CALS implementation converts current paper flows to digital flows in a file transfer environment, longer term objectives target new functional capabilities that will be achieved through redesign, integration, and consolidation of the numerous parallel, duplicative processes that have grown up in our current paper-based culture.

40.3.2.1. **CALS integrated data bases and processes.** CALS will exploit the additional emerging power of the computer by redesigning data formats and integrating what are now separate and often redundant collections of data. These actions will fully integrate support into the design process, as well as

develop a variety of logistics data products from a design data base. This integration will produce large savings in productivity and result in improved readiness through much improved planning and support. CALS integrated data bases and processes will be designed to the extent feasible through industry cooperative efforts, because industry must implement most of the systems to create this capability.

40.3.2.2. **CALS Integrated Weapon System Data Base (IWSDB).** The logical collection of shared data for a specific weapon system that is contained within CITIS and government data bases, and is used throughout the weapon system life cycle is called an IWSDB. The physical location of the data may be distributed among contractor or government automated data processing systems. The CALS IWSDB structure is evolving and will be the basis for the integrated, shared data environment. The CALS IWSDB will provide a logical (not physical) collection of shared data to support both CITIS and government users throughout the weapon system life cycle. The IWSDB will be governed by an active data dictionary implemented through standards such as the Information Requirements Dictionary System, and will be consistent with CALS data standards, including PDES as well as data standards to control support data. The data standards will provide data element definitions, together with the data relationships and rules for data integrity and data consistency required to accommodate the changes in user requirements and computer technologies that are inevitable throughout the 20 to 40 year life of the weapon system.

40.3.2.3. **CALS technology development.** CALS must evaluate alternative technology approaches before committing to full-scale implementation of the IWSDB concept. This is being done through a series of technology R&D and demonstration programs that have been prioritized to facilitate the transition from interfaced to integrated systems and processes. Key development areas include advanced product data technology for CAD/CAE/CIM, electronic technical manual creation and delivery systems, concurrent engineering and integration of R&M with design, and telecommunications/gateway access to parts data bases.

40.3.2.4. **IWSDB mechanisms.** As with near term implementation, the mechanisms for implementing longer term CALS objectives will be a set of core requirements that address the functional and technical needs of acquisition managers. The difference will be the increasing emphasis on redefinition of functional requirements in a concurrent engineering environment, and on the application of appropriate supporting technology such as data management and access standards. The technology and standards for interfacing systems will be necessary but not sufficient for implementation of long term CALS objectives, and transition

bridges between the capabilities of interfaced and integrated systems will be needed.

40.3.2.5. **Long term CALS benefits.** Achieving these long term CALS objectives will yield the following benefits:

a. More complete integration than is possible within interfaced "stovepipe" systems of contractor design, manufacturing, and support data systems based on advanced product data models.

b. Near real-time updates of technical data to match weapon system configuration.

c. On-line access by authorized government users to distributed contractor and government data bases.

d. Data bases owned by DoD, but possessed and maintained either by DoD or by contractors.

e. Automated technical manual and training material authoring and delivery.

f. Automated interfaces of spares procurement with flexible manufacturing systems.

g. Integration of R&M engineering as an on-line part of the CAD/CAE design processes.

h. Application of concurrent engineering strategies and programs to optimize product and acquisition process design and development.

40.3.3. **CALS implementation schedules.** Implementation of CALS requirements is technically and economically feasible now. Implementation of technology to interface contractor systems with government systems is already in process, and will continue into the mid-1990's and beyond. Planning and development for system integration has commenced; technology R&D activities are already underway, and implementation will start in the 1990's. DoD and industry will be implementing a mixture of system interfacing and system integration initiatives throughout the next decade.

40.4. **CALS management organizations.** To achieve these objectives, the Office of the Secretary of Defense (OSD) established a CALS policy office within the office of the Assistant Secretary of Defense (Production and Logistics) to develop policy and plans for CALS implementation, develop standards and corporate architecture elements, and facilitate accelerated implementation within industry. The Services and DLA

have also designated CALS offices to meet the program objectives identified in table 1. The DoD CALS Steering Group established by the Deputy Secretary of Defense provides policy guidance and coordinates implementation activities.

TABLE I. **CALS points of contact.**

DEPARTMENT/ AGENCY	ADDRESS	COMMERCIAL	AUTOVON
OSD	CALS Point of Contact DASD(S)CALS The Pentagon, Room 2B322 Washington, DC 20301-8000	202-697-0051	227-0051
ARMY	CALS Point of Contact HQTRS, US Army Material Command, ATTN: AMCRE-C 5001 Eisenhower Avenue Alexandria, VA 22333-0001	703-274-9759	284-9759
NAVY	CALS Point of Contact Naval Supply Systems Command, ATTN: PML 5505-T Crystal Mall #3, Room 517 1931 Jefferson Davis Highway Arlington, VA 22202	202-694-9111	225-5728
AIR FORCE	CALS Point of Contact HQTRS, Air Force Systems Command, ATTN: PLXC Andrews AFB, DC 20334-5000	301-981-3915	858-3915
DEFENSE LOGISTICS AGENCY	CALS Point of Contact DLA-Z (DCLSO) 6301 Little River Turnpike Beauregard Square, Suite 310 Alexandria, VA 22312	703-274-4210	284-4211 or 284-4212

THE DEPUTY SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

5 AUG 1988

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
DIRECTOR, DEFENSE LOGISTICS AGENCY

SUBJECT: Computer-aided Acquisition and Logistic Support (CALS)

To achieve productivity and quality improvements, my September 1985 letter on CALS set the goal of acquiring technical data in digital form (rather than paper) for weapon systems entering production in 1990 and beyond. We have now taken a major step toward routine contractual implementation. The Department of Defense (DoD) has coordinated with industry the first in a series of CALS issuances of national and international standards for digital data delivery and access. These standards have been published in MIL-STD-1840A, "Automated Interchange of Technical Information," and supporting military specifications. The CALS standards will enable either digital data delivery or government access to contractor-maintained technical data bases.

Effective immediately, plans for new weapon systems and related major equipment items should include use of the CALS standards. Specifically:

- For systems now in full-scale development or production, program managers shall review specific opportunities for cost savings or quality improvements that could result from changing weapon system paper deliverables to digital delivery or access using the CALS standards.

- For systems entering development after September 1988, acquisition plans, solicitations, and related documents should require specific schedule and cost proposals for: (1) integration of contractor technical information systems and processes, (2) authorized government access to contractor data bases, and (3) delivery of technical information in digital form. These proposals shall be given significant weight for their cost and quality implications in source selection decisions. The CALS standards shall be applied for digital data deliverables.

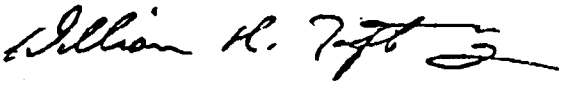
DoD components shall program for automated systems to receive, store, distribute, and use digital weapon system technical information, including achieving the earliest possible date for digital input to DoD engineering data repositories. These systems shall be configured or adapted to support the CALS

FIGURE 3. **CALS implementation requirements.**

standards. Plans for CALS implementation and productivity improvements will be addressed in Defense Acquisition Board and Major Automated Information System Review Council acquisition reviews, and in corresponding Service and Agency reviews.

Each application decision shall be made on its own merits with respect to the productivity and quality improvements expected at either prime contractor or subcontractor level. The Under Secretary (Acquisition) will issue further guidance on contract requirements, such as CALS options, in invitations for bid; opportunities and safeguards for small business and other vendors and subcontractors; government and contractor incentives; and funding mechanisms for productivity-enhancing investments in automation and CALS integration by defense contractors.

I believe that CALS is one of the most important and far reaching acquisition improvements we have undertaken. I would appreciate having the Assistant Secretary (Production and Logistics) receive your plan of action within 90 days, including identification of systems where opportunities exist for cost savings or quality improvement through application of CALS technology, the investment required to achieve these benefits, and proposed schedules for implementation.



William H. Taft, IV

cc: Under Secretary of Defense (Acquisition)
Assistant Secretaries of Defense

FIGURE 3. **CALS Implementation Requirements - Continued.**

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APPENDIX B

APPLICATION GUIDANCE FOR ACQUISITION OF DIGITAL DELIVERABLES

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10. SCOPE

10.1. **Applicability.** This appendix provides guidance to government activities on acquisition of digital deliverables in the functional areas that currently produce the greatest volume of hard copy technical data. It is applicable to all Department of Defense (DoD) components which acquire weapon systems and equipment.

10.2. **Purpose.** This appendix provides decision guidance and model language for tailoring the wording of standard DoD Requests for Proposal (RFP's) and Contract Data Requirement Lists (CDRL's) to allow and encourage the integrated preparation and submission of, or access to, digital data for design, manufacturing, and support applications.

20. REFERENCED DOCUMENTS

See list of references appearing in Appendix A.

30. DEFINITIONS

See list of terms and acronyms appearing in Appendix A.

40. GENERAL GUIDANCE

40.1. **Contracting for digital data.** A major thrust of the Computer-aided Acquisition and Logistic Support (CALS) program is delivery of, or access to, weapon system data in digital form. A second major thrust is the integration of the data bases which produce that data and make it available for use. Implementation of these thrusts requires changes to DoD solicitations and contracts, including their attachments and enclosures. These changes should be made with full consideration of the ability of contractors to provide digital data and the ability of government activities to make cost effective use of digital data deliverables or access.

40.2. **Tailoring and revision of functional standards.** Existing functional standards may be insufficient to invoke these alternatives contractually. Many of these standards were written to address not only hard copy delivery requirements, but also style and format provisions designed for the paper environment. Therefore, tailoring is frequently required when they are cited by the contract. In some cases, tailoring out inappropriate requirements may be insufficient, and alternative language may be needed as part of the statement of work. The acquisition manager should identify necessary changes to functional standards and forward them to the appropriate preparing activity to facilitate revision and publication of updated functional standards.

40.3. **Application of the master decision template.** The master decision template (Figure 1, 5.2.5) provides guidance for analysis of how technical data should be acquired by the government from the contractor. This appendix discusses the application of the master decision template to specific functional areas, including the appropriate technical standards and specifications.

40.3.1. **Tailoring to meet program requirements.** In each case, the master template must be tailored to meet the requirements of the functional area. In addition, each weapon system program may include unique requirements for which additional program-specific tailoring will be needed. Most of the applicable CALS standards and specifications contain contract-negotiable options among which the acquisition manager must choose to satisfy program-specific requirements, including multiple classes or types of data formats, and different requirements for interim and final deliverables. Consequently, the acquisition manager must apply this handbook as a guidance document, not as a rulebook.

40.3.1.1. **Classes of data.** Section 1 (scope) and section 6.2 (ordering data) of a military specification will list classes (types, levels) of data addressed by the specification. Usually, the acquisition manager must choose one of these classes based on the program's information requirements. For example, MIL-D-28000 includes several data classes, including Class I for technical illustrations, Class II for engineering drawings, Class III for electrical and electronic applications, and Class IV for numerical control machining data. Class I is usually most suitable for technical manuals, class II for engineering drawings and book form drawings, etc.

40.3.1.2. **Contract negotiable options.** Section 6.2 (ordering data) of a military specification also summarizes other contract-negotiable options allowed to be ordered under the specification. For example, MIL-M-28001 requires delivery of an SGML-tagged source file as a final deliverable. However, it also allows delivery of a page description language (PDL) file as an interim deliverable or as a second final deliverable.

40.3.1.3. **Data delivery procedures.** CALS military specifications provide technical requirements for delivery of digital data. MIL-STD-1840 provides rules for organizing files of digital data (for example, MIL-M-28001 text files and MIL-D-28003 graphics files) into a complete data package, such as a technical manual in digital form. Therefore, in most cases delivery of digital data must be specified in accordance with both MIL-STD-1840 and an appropriate military specification.

40.3.2. **Selection of multiple options.** The alternatives contained in the decision template are not mutually exclusive, and are applied individually to each technical data requirement within the functional area. For example, the acquisition manager may choose digital document image data for preliminary review and approval, and processable data files for final deliverables. However, early selection (or rejection) of one deliverable option may cause that option or other options to be excluded from further consideration for deliverables in subsequent program phases. For example, an early decision to require technical illustrations in raster form may result in creation of data that cannot easily be converted to vector form.

40.3.3. **Data item descriptions (DID's).** A DID identifies specific data requirements, which may include the format of a report used to display the data. Most current DID's were prepared with only the hard copy (paper, aperture card, etc.) document environment in mind. In a CALS environment, two aspects of data acquisition must be examined to determine whether existing DID's are adequate: the deliverable itself (documents,

processable data files, interactive access), and the delivery mode (physical media or telecommunications).

40.3.3.1. **Documents and media.** If a document is acquired, in either hard copy (paper, aperture card, etc.) or digital (raster, PDL, etc.) form, then this requirement is not additive to the basic set of data requirements and the existing DID can be used without revision. Similarly, a new DID is not required when a physical media delivery mode is specified, because this requirement is not additive to the basic set of data requirements. If a telecommunications delivery mode but not interactive access is specified (that is, when electronic mail is used), a new DID is also not required.

40.3.3.2. **Processable data files.** The basic set of data requirements does change when processable data files are acquired, even though the exact same data elements are included. Therefore, new DID's must be prepared for processable data files. Until such DID's are widely available, the acquisition manager should prepare a program-specific DID and submit it for approval. Such program-specific DID's will be the foundation for revising the body of current DID's that are available for all acquisition programs.

40.3.3.3. **Interactive access.** In the case of interactive access, the acquisition manager is acquiring a service, not merely deliverable documents or data. In this case, the requirements will have to be addressed in the contract statement of work. In some cases, such as when a contractor is maintaining and updating the technical data for government users after its original creation, the requirements may be subject to a separate contract action.

40.4. **Technology development and insertion.** One characteristic of CALS system integration initiatives will be application of new technology that is currently still in the research and development process. However, the technology for interfacing systems is also evolving. This is reflected in all aspects of technical data delivery and access, and in the telecommunications and computer-aided capabilities through which data delivery and access is implemented. Data which cannot cost effectively be provided through interactive access today will be routinely exchanged using this medium in the future. New specifications and standards will be developed and implemented to allow digital documents and processable data files to be more efficiently managed. Computer system vendors will provide more capable hardware and software that can integrate processable data files through which different forms of data (text, graphics, etc.) are treated as a single, compound data structure. Acquisition

managers should be alert for opportunities to apply this more advanced technology, as well as cautious about premature implementation. CITIS and government technical information system architectures must plan for technology insertion, and for the attendant problems of managing both multiple concurrent capabilities (e.g., raster and vector graphics) and multiple concurrent technology levels (e.g., untiled and tiled raster).

50. DETAILED GUIDANCE

50.1. **Organization of guidance sections.** This appendix is organized by functional area. Each section can be used separately or in combination with others to contract for digital CALS data. The functional areas covered in this release of MIL-HDBK-59 are:

a. 50.2 Technical Manuals.

b. 50.3 Technical Data Packages (including Engineering Drawings, Product Specifications and Book Form Drawings, and other Technical Data Package components).

c. 50.4 Logistic Support Analysis Records.

d. 50.5 Training Products.

Among the functional areas that will be included in future releases of MIL-HDBK-59 are:

a. 50.6 Technical Specifications and Reports.

b. 50.7 Interactive Maintenance Aids.

50.2. ACQUISITION OF TECHNICAL MANUALS

50.2.1. **Scope.** This section addresses the selection of digital data deliverables for technical manuals (technical orders in the Air Force). Technical manuals are the operating and maintenance instructions for military technicians. They contain a combination of textual narrative and illustrative graphic images presented in a formal, structured, page-oriented format governed by specific functional standards. These manuals have traditionally been prepared and delivered in hard copy form as camera-ready copy, which are, in turn, printed in large lots.

50.2.1.1. **Digital data deliverables.** The implementation of automated data processing technology offers numerous improvement opportunities in both preparation of technical manuals, and the delivery, storage, distribution, and maintenance of manuals. Technical manual data in digital form can be stored on magnetic or optical media, transmitted and shown on computer terminals, and printed on demand. Acquiring technical manual deliverables in digital form allows the military user to view required information without printing it on paper. Acquiring processable

data files provides the opportunity to tailor outputs for particular users and uses. Data can be reformatted into step-by-step trouble-shooting formats for maintenance personnel, it can be adapted to expert system diagnostic programs, or it can be used to generate training aids.

50.2.1.2. **Advances in computer capability.** Many of today's computer systems still manage and interchange textual data differently from graphics data, making it difficult to insure consistency between the narrative and illustrative materials required in technical manuals. Technology and standards (such as ODA/ODIF) are being developed and implemented to overcome this problem, and will become increasingly available. Contractors will implement this technology rapidly, and acquisition managers should anticipate improved tools for maintaining and delivering technical manual data.

50.2.1.3. **Data sources for technical manuals.** The Logistic Support Analysis Record (LSAR) consolidates logistics-oriented technical information in conjunction with data for the various engineering disciplines and Integrated Logistic Support elements to reduce redundancy, facilitate timely usage, and enhance consistency among data elements and disciplines. The quality and productivity of technical manual development is enhanced when the LSAR is used as a principal data source for this process. Integration of the data bases that produce LSAR task analysis (and other) data, technical manuals, and training materials will provide even greater benefits.

50.2.2. **Decision node discussion.** Figure 4 applies the master Decision Template for Acquisition of Digital Deliverables to technical manual deliverables. The following paragraphs discuss the required decisions shown in figure 4.

50.2.2.1. **Deliverable options - decision #1.** Technical manual data can be delivered as composed documents or processable files. Interactive access to data bases containing technical manual data is a future goal. The composed document deliverable option offers the least flexibility, even in digital form. It is a static, formatted presentation of the manual, which can only be archived, viewed, and printed after receipt. Processable files, on the other hand, offer more robust capabilities. These files can be updated or transformed into many different data types. With appropriate data processing systems, processable files can support creation of job guides, training documents, and eventual on-line distribution of selected portions of the data to maintenance personnel.

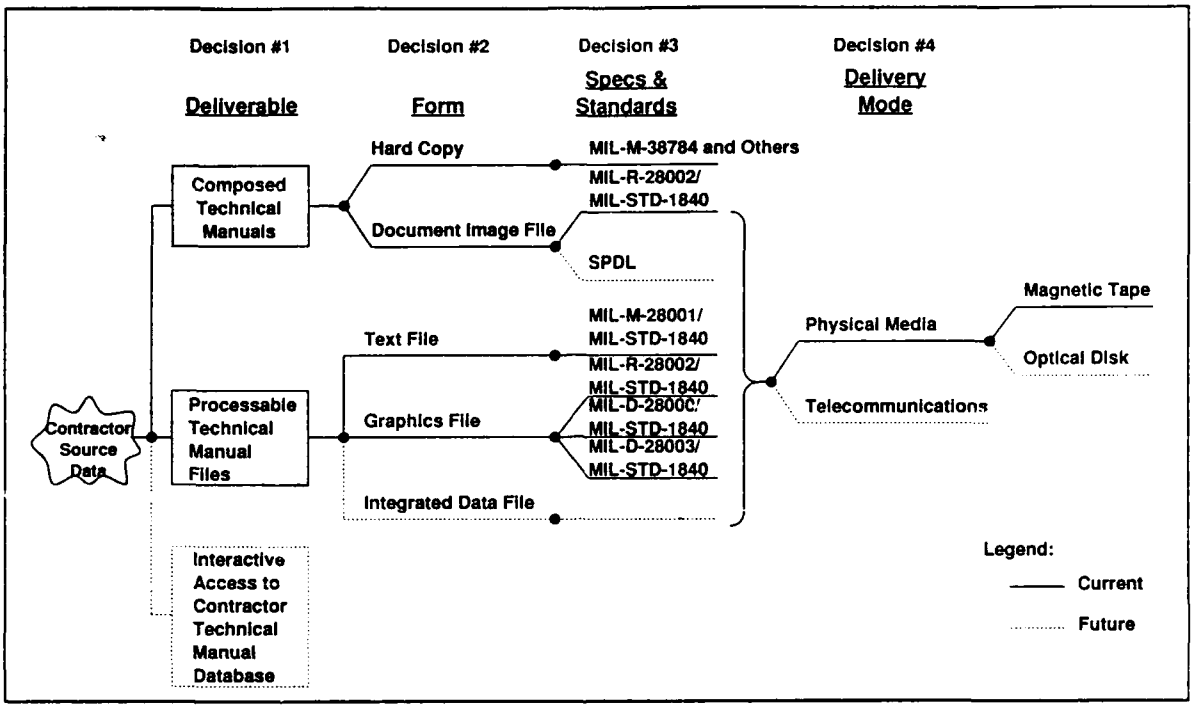

FIGURE 4. **Decision template for technical manuals.**

50.2.2.1.1. **Destination system constraints on form.** Processable data files are preferable to composed documents, but the presence of both text and graphics may cause some difficulty because not all presently installed computing equipment and software can simultaneously process text with embedded graphics. This issue is rapidly disappearing. Nonetheless, during the period of intended use, installed hardware and software at both the contractor's site (i.e., the source system) and government's site (i.e., the destination system) will be the deciding factor as to which form the deliverable may take.

50.2.2.1.2. **Interim dual deliverables.** Requirements for technical manual deliverables may include both composed documents in digital form and processable data files. However, until more advanced government systems are available, it may be necessary to accept, for each deliverable, both one hard copy (paper) technical manual for approval and reproduction/distribution, and a digital form of that manual for archiving or update and maintenance. When the government implements more advanced

computer systems, processable technical manual files (with or without composed document image files of the technical manual) should suffice. Check with the appropriate Service CALS point of contact (Appendix A) for up-to-date guidance.

50.2.2.2. **Forms options - decision #2.** A technical manual is made up of both text (including narrative and tables) and graphics. Integrating these elements into a complete technical manual, and dealing with user requirements that are different for interim review and approval than for final delivery, may require more than merely choosing a single optimum form. The acquisition manager may have to choose the appropriate forms for multiple deliverables (eg, a processable data file that can be updated and maintained, plus a document image file that can be displayed and printed on demand), or for the elements of a single deliverable (eg, processable data files for text, and document image files for graphics).

50.2.2.2.1. **Forms options - decision #2 (for composed documents).** As shown at the top left of figure 4, if composed documents have been selected at decision #1, the forms for technical manual delivery can be either hard copy (paper or microfilm) or a digital composed document image file. The digital form of this deliverable consists of composed page images of the full manual. It offers greater advantages than hard copy in storage, distribution, viewing, and printing. It also provides slightly more flexibility than hard copy with respect to future data uses, although its format will be fixed and unyielding. It is a two-dimensional image of each manual page, offering no further updating or processing features beyond replication. Neither the hard copy nor the digital form supports update or maintenance except with great difficulty.

50.2.2.2.2. **Forms options - decision #2 (for processable files).** If processable files are selected at decision #1, the forms for technical manual delivery can be either one or more sets of text and graphics files, or an integrated data file that contains text and graphics in a compound data architecture. The use of an integrated data file is a future option. At present, a processable technical manual file will be comprised of one set of files for textual or numeric data and a separate set of files for graphic illustrations and drawings. In the future, these same text and graphics data will be available as integrated data files with configuration management and positioning features. However, the technologies to accomplish such integration are just beginning to be introduced.

50.2.2.2.3. **Forms option - decision #2 (mixed mode).** A technical manual typically contains about 60% text and 40%

graphics. The graphics may include illustrations imported from a design data base, artwork that has been newly created on an advanced authoring work station, and illustrations originally created on the drafting table that must now be treated as a digital image. The text will include both straight narrative and tables, and the tables may be so elaborate that it is technically easier to construct them as if they were a graphic illustration, rather than organized textual information. In cases such as this, the digital deliverable may be made up of files of processable data (e.g., the text and the graphics imported from design) accompanied by composed document image files (e.g., illustrations that have been raster scanned from hard copy artwork). See the discussion of raster versus vector graphics below.

50.2.2.3. **Specification and standard options - decision #3.**

50.2.2.3.1. **Decision #3 for composed documents.** Technical manuals acquired as composed documents may be acquired in the form of either camera-ready masters or digital document image files. Camera-ready masters should be delivered in accordance with MIL-M-38784 or other appropriate MIL-SPECs or MIL-STDs. Digital document image files in raster form should be acquired in accordance with MIL-R-28002. MIL-R-28002 provides two options: Type I (the default option) for untiled raster data, and Type II for tiled raster data, for which a new national standard is being developed. Storage of document images in a Page Description Language (PDL) provides an alternative form which is slightly easier to maintain. A PDL file is a program that is executed by an interpreter that controls a raster printer or other output device. PDL document image files can be acquired as interim deliverables, or as final deliverables in addition to (but not in place of) processable data files using MIL-STD-1840 and MIL-M-28001. However, these are not standardized, for a Standard Page Description Language (SPDL) is still being developed.

50.2.2.3.2. **Decision #3 - specifications and standards for graphics.**

50.2.2.3.2.1. **Raster versus vector graphics.** Graphics data may be in either raster or vector formats. Assuming an adequate scanning resolution, raster provides nearly exact fidelity for illustrations, whereas vector graphics translates data between different sending and receiving system native forms. (For example, a line expressed as a pair of end points, versus a line expressed as an origin, direction, and length.) This can introduce errors, even when an intermediate neutral format (the standard) is agreed upon. Vector representations are easily edited, maintained, and updated, whereas raster representations

can be edited only with great difficulty. Vector representations also have the advantage of much smaller file size, even when the raster bit-map image has been compressed using an algorithm such as that specified by MIL-R-28002. Nevertheless, raster graphic illustrations are frequently encountered because scanning remains the only practical way of converting a legacy of hard copy drawings into digital data. Despite the limitations of raster data, the practical consequence of the hard copy legacy requires supporting both raster and vector formats for graphics. Raster illustrations belong to the class of document image files discussed in the previous paragraph and should be acquired using MIL-R-28002.

50.2.2.3.2.2. **Specifications for vector graphics.** There are two choices of standards to consider for vector graphics: MIL-D-28003 for CGM and MIL-D-28000 for IGES. Generally, the Computer Graphics Metafile (CGM) is appropriate for graphics in the categories of illustrations, charts, etc., while engineering drawings and technical illustrations derived from design data are the domain of IGES, the Initial Graphics Exchange Specification. CGM files are smaller than equivalent IGES files by a factor of up to four. For technical manuals, CGM is the preferred option but IGES is allowed. Extensions to the standard to allow translation of native CAD data into CGM are still being developed. If technical manual illustrations are being derived directly from design data, then system limitations may constrain the choice of delivery standard. In selecting the appropriate option, the acquisition manager should recognize the potential problems created by multiple translation steps (e.g., unique CAD system to IGES to CGM). MIL-D-28003 specifies an Application Profile with two options: Level I for publication quality data, and Level II for draft quality data. Uncompressed raster data can be included in a CGM file, but MIL-D-28003 should only be used where the predominate form of the graphics information is vector. MIL-D-28000 specifies several subsets of IGES designed to meet different application needs. In most cases, when IGES is used for technical manual illustrations, the Class I Technical Illustration subset is appropriate. In a few cases, program requirements may make it appropriate to specify use of the Class II Engineering Drawing subset. In either case, data would be delivered in either ASCII or compressed ASCII, as specified by MIL-D-28000.

50.2.2.3.3. **Decision #3 for processable text.** Processable text data files should be acquired in accordance with MIL-M-28001, which implements the Standard Generalized Markup Language (SGML). An SGML Document Type Definition and Output Specification must be selected from MIL-M-28001, or created in accordance with the pro-

visions of MIL-M-28001, to meet the document structure and format requirements of the technical manual.

50.2.2.4. **Digital delivery mode options - decision #4.** As shown at the right side of figure 4, physical media are currently the only practical option for the delivery of document image files or processable data files. While telecommunications bulk transfer of these files may be possible, it is usually not an economical option because of the large volume of data contained in these files, particularly the raster document image and raster graphics files. When interactive access to a contractor's technical manual data base becomes a third deliverable option (see left side of figure), then telecommunications may be warranted as a delivery mode for interim deliverables. In a few cases, telecommunications networks are already being used for on-line review and approval of technical manuals or portions of manuals.

50.2.2.4.1. **Decision #4 - magnetic tape.** As shown at the far right of figure 4, the preferred physical media option to use is magnetic tape. Standards for tape media are contained in Appendix D of this handbook. It is a mature, stable technology that is usually available at all sending and destination systems.

50.2.2.4.2. **Decision #4 - optical disk.** Optical disk or CD-ROM will be alternative physical media option in the future, and are generally well suited for data archiving because they can accommodate very large volumes of data quite efficiently. However, because they are relatively new technologies, optical disk and CD-ROM may necessitate new hardware investments by both the contractor and the government to accommodate this media, and they are not yet standardized.

50.2.2.5. **Digital deliverable summary.** Selection of the options at each node of the Technical Manuals decision template should be aligned to the needs of the organizations responsible for technical manual publication and maintenance within each military department. However, requirements for interim deliverables that are provided only for review and approval (verification) may be evaluated differently than are final deliverables. Delivery of processable data is less important when the principal applications are view and annotate, than when the intended applications are update/maintain and process/transform. Consequently, document image files may be more appropriate early in the life cycle of the program; however, processable data files should be the deliverable of choice when the government assumes the responsibility for technical manual update and maintenance. These files should be usually be delivered on magnetic tape.

50.2.2.6. **Example - delivery of digital data into the Automated Technical Order System (ATOS).** For example, the appropriate selection options for technical manuals delivered to the Air Force Automated Technical Order System should be processable technical manual files composed of:

a. SGML text files in accordance with MIL-M-28001 and MIL-STD-1840.

b. Raster graphics files in accordance with MIL-R-28002 Type I and MIL-STD-1840.

c. Vector graphics files in accordance with MIL-D-28000 Class I and MIL-STD-1840.

50.2.3. **Decision guidelines.** As noted previously, digital delivery options for technical manuals are not mutually exclusive. There will often be cases when several options will be combined for specific deliverables during a weapon system acquisition. The decision criteria presented in this handbook are intended to aid in selecting the best options. The following is guidance for applying the criteria to technical manuals.

50.2.3.1. **Intended data use.** The following general guidelines are provided:

a. Select processable files if internal or third party update and maintenance is anticipated, document image files if no further revision or change is anticipated.

b. Select processable files if the future creation of specialized documents and aids is envisioned.

c. Select vector graphics files if update and maintenance of illustrations and drawings is desired, raster graphic files if hard copy illustrations are being converted to digital form.

50.2.3.2. **Life cycle phases.** The acquisition life cycle phase of the weapon system and its technical data is an important consideration. The following general guidelines apply:

a. Select document image files if a program is in a late phase (i.e., full scale development, or production and deployment) and large amounts of data already exist in hard copy.

b. Select document image files for interim deliverables for in-process review prior to assumption of management and maintenance responsibility.

c. Select processable data files for final delivery, when maintenance and update responsibility is assumed by the government.

50.2.3.3. **Delivery cost.** Costs associated with the delivery process are a consideration. The following guideline applies:

Select tape for delivery of large volumes of digital data.

50.2.3.4. **Available technology.** The limitations of the government receiving system are a consideration. The following guideline applies:

Select document image files if the receiving system lacks update and maintenance capability, processable data files for subsequent processing and transformation.

50.2.4. **Contract implementation of digital data delivery.** There are five basic, yet non-exclusive, digital deliverable alternatives. These are summarized in table II.

TABLE II. **Technical manual forms and standards.**

Deliverable and Form	Preferred Delivery Mode	Implement With
1. Document Image File	Magnetic Tape	MIL-R-28002 or MIL-M-28001 (PDL only), and MIL-STD-1840
2. Processable Text File	Magnetic Tape	MIL-M-28001 and MIL-STD-1840
3. Raster Graphics File	Magnetic Tape	MIL-R-28002 and MIL-STD-1840
4. Vector Graphics File-IGES	Magnetic Tape	MIL-D-28000 and MIL-STD-1840
5. Vector Graphics File-CGM	Magnetic Tape	MIL-D-28003 and MIL-STD-1840

50.2.4.1. **Digital data deliverables.** MIL-M-38784, Technical Manuals: General Style and Format Requirements, is commonly used

to order technical manuals; other specifications govern specific types of manuals, and are often invoked in conjunction with MIL-M-38784. When delivery (or access) of technical manuals in digital form is planned, all relevant functional standards must be reviewed to ensure that they do not specify requirements which are incompatible with the applicable CALS standards.

50.2.4.2. **Ordering requirements.** In addition, the tailored MIL-M-38784 should be referenced in Block 16 of the CDRL (DD Form 1423) to specify delivery of digital data in accordance with MIL-STD-1840. The physical media standards for magnetic tape delivery mode shown in Appendix D should also be specified.

50.3. ACQUISITION OF TECHNICAL DATA PACKAGES (TDP).

50.3.1. **Scope.** A technical data package is a technical description that is adequate to support acquisition of an item, including engineering and production. The technical description consists of all applicable technical data, such as engineering drawings, associated lists, product and process specifications and standards, performance requirements, quality assurance provisions, and packaging details. This section addresses acquisition of the elements of a TDP.

50.3.2. ENGINEERING DRAWINGS.

50.3.2.1. **Scope.** This section addresses the acquisition alternatives for engineering drawings, a major component of Technical Data Packages (TDP's). The emphasis is on those drawing levels (as defined in DoD-D-1000) that will be used to manufacture hardware: Level 2 (production prototype and limited production) and Level 3 (production), rather than Level 1 (conceptual and developmental design). Typically, only Levels 2 and 3 are delivered to DoD repositories for archiving and subsequent application and use. This section, and the section on product specifications and book form drawings that follows, distinguish between technical data that is primarily graphic with associated text annotation, and technical data that contain a more proportional mix of graphics and text.

50.3.2.2. **Overview.** Engineering drawings are documents that disclose directly or by reference, by means of graphic and textual information, the physical and functional end-product requirements of an item. Geometry, material requirements, and process data, along with notational explanations pertaining to specific functions and features of the representation, are its typical contents. Process and manufacturing engineers interpret

the drawings and create additional information on the material and physical processes required to fabricate the parts, assemblies, or products described by the engineering drawing. In addition, machine instructions can be created from the drawing by a process engineer to direct the fabrication and inspection processes for parts fabricated on computer numerical control and automated production machines.

50.3.2.2.1. **Product definition data.** An engineering drawing is a subset of what CAD users have come to call product definition data. Product definition data includes the information needed for design, analysis, manufacture, test, and inspection (see the definitions in Appendix A, Section 30). Product definition data, in turn, is a subset of product data, which adds the elements of life cycle support to those of design and manufacture. Even though an engineering drawing does not contain all product definition data, let alone all product data, it is the accepted form in which product design information is communicated and documented for the record in a hard copy environment. It will continue the serve this same function while users transition into a CIM environment.

50.3.2.2.2. **Drawing conventions and standards.** Because engineering drawings meet a wide scope of information and user needs, conventions and standards governing their creation have been developed to ensure consistency of creation and interpretation. These requirements have been codified in a hierarchy of military standards and specifications, with DoD-D-1000 and DoD-STD-100 at the apex.

50.3.2.2.3. **Evolving technology for engineering drawing data.** Some design work is still being done on the drafting table, but users are increasingly adopting computer aided design (CAD) technology. Regardless of how the engineering data is created, however, it can still be exchanged between users in either hard copy or digital form.

50.3.2.2.4. **Use of raster graphics.** DoD stores over 200 million engineering drawings and specifications in its repositories, and most of this information is duplicated in the repositories of the defense contractors who created the drawings. The storage of engineering drawings and the generation of spares reprocurement packages has become increasingly difficult and time consuming as the volume of hard copy data in DoD repositories has continued to expand. Thirty years ago, engineering drawing users transitioned from paper/vellum to aperture cards as the medium of interchange for drawings. Now that new technology is available, and storage of engineering drawings on aperture cards can no longer keep up with user needs, the Services' data repositories have initiated

the process of raster scanning hard copy engineering drawings for more compact storage on optical disk. While this adds no intelligence to the engineering data itself, it does significantly improve data management capabilities.

50.3.2.2.5. **Computer aided design (CAD).** Defense contractors are expanding the use of CAD and computer integrated manufacturing (CIM) systems to automate design and manufacturing functions. These CAD and CIM systems create and use vector graphics files, defining the geometry and associated data attributes of weapon system assemblies and components. This technology facilitates use of other automated tools, such as those for reliability and maintainability (R&M) analysis, in the design process. PDES, an evolving DoD and industry-supported data standard for description of the product over its life cycle, will provide additional functionality when it becomes available. PDES used with CIM technology will facilitate the integration of engineering design, manufacturing, logistic support, and configuration management data. Engineering drawings, an output of the engineering design process, will be able to be extracted directly from product data, largely without intermediate manual processes. Ultimately, engineering drawings may no longer be necessary for spares reprocurement, particularly when PDES product data can be directly transferred between CIM systems.

50.3.2.3. **Decision node discussion.** The master Decision Template for Acquisition of Digital Deliverables is applied to the Engineering Drawings Application as shown in figure 5. Each decision is discussed in the following text.

50.3.2.3.1. **Deliverable options - decision #1.** The first column lists the first set of deliverable options for engineering drawings. The current choices are engineering drawing images or the more comprehensive product definition data files used by some contractors. Interactive access to engineering design data bases is a future goal.

50.3.2.3.2. **Form options - decision #2.**

50.3.2.3.2.1. **Forms options - decision #2 (for engineering drawing images).** The deliverable form options for engineering drawing images are hard copy and raster image files. Paper, vellum, mylar, roll microfilm, and aperture cards are some examples of the media used for hard copy. The aperture card has become the accepted medium for acquiring reproducible hard copy images of engineering drawings, although other forms are still in use. Aperture cards or other hard copy forms delivered to DoD automated engineering data repositories will be converted to raster images for storage. This conversion can be avoided by

choosing delivery of a raster image file. Raster image files are the representation of digitally scanned paper drawings or aperture cards. There is no intelligence in the raster image file. Human interpretation is required, as it is with paper drawings or aperture cards. Raster image files are primarily useful for data that are to be used in a print on demand, hard copy (paper or aperture card) mode.

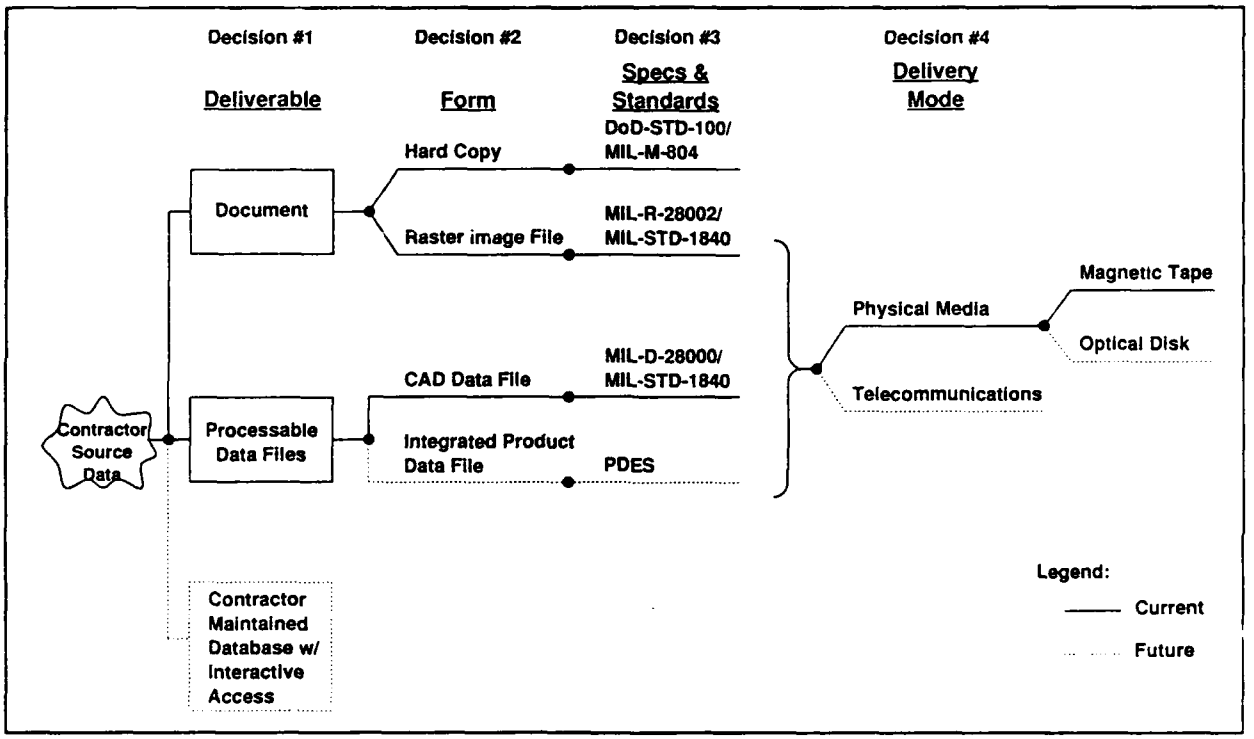

FIGURE 5. **Decision template for engineering drawings.**

50.3.2.3.2.2. **Forms options - decision #2 (for product definition data files).** The options for product data definition files are the CAD data file and the integrated product data file. The CAD data file consists of vector data with geometrically accurate and precise representations of the product, together with associated annotations (dimensions, tolerances, etc.). This CAD data can be either two-dimensional or three-dimensional, although the CALS standard (MIL-D-28000) described below defines a three-dimensional CAD data file. CAD data contains limited intelligence, and is suitable for automated interrogation and manipulation, such as alternate views of the object or path generation for numerically controlled manufacturing machinery. DoD repositories plan to accept digital data created by CAD systems as input, although in the near term the principal output

medium from those repositories will be hard copy or raster images. The integrated product data file will contain more information. It will include three dimensional features, solids modeling, parametric design, material specifications, design tradeoffs, process and manufacturing engineering, and machine instructions for automated parts manufacturing. This option requires technologies that are not yet fully developed or in widespread use, and for which standards are still under development.

50.3.2.3.3. **Specifications and standards options - decision #3.** DoD-STD-100 and DoD-D-1000 are the functional standards controlling the subject matter and content requirements of engineering drawings. Changes to these functional standards, or new standards, may need to be developed if current or future CAD technology leads to changes in the subject matter or content of engineering drawings. Technical specifications and standards are well defined for aperture cards, raster image files, and CAD data files.

50.3.2.3.3.1. **Specifications and standards options - decision #3 (for engineering drawing images).** Aperture cards are governed by MIL-M-38761 and MIL-STD-804 (hollerith data) requirements. MIL-M-9868 governs the microfilming of engineering documents. Raster image files are governed by MIL-R-28002. The default format for delivery of raster data is MIL-R-28002 Type I (untiled). However, MIL-R-28002 Type II (tiled) may be negotiated if the appropriate sending and receiving system capability is in place.

50.3.2.3.3.2. **Specifications and standards options - decision #3 (for product definition data files).** CAD data files are governed by MIL-D-28000 (IGES). In most cases, the MIL-D-28000 Class II subset (engineering drawings) is appropriate. For electrical and electronic applications, the MIL-D-28000 Class III subset may be more appropriate, Specialized data requirements (which technically are not engineering drawings) should be met with other IGES subsets (eg, Class IV for numerical control data). In either case, data would be delivered in either ASCII or compressed ASCII, as specified by MIL-D-28000. The PDES standard (when available) for the integrated product definition data file should be considered for future deliverables from programs that are in the very early phases of concept development. However, use of PDES will offer the opportunity to acquire information that exceeds the current scope of engineering drawings, and may require development of new functional standards, or changes to DoD-STD-100 and DoD-D-1000.

50.3.2.3.4. **Digital delivery mode options - decision #4.** The digital delivery mode options are shown at the right side of

figure 5. Physical media is currently the only practical option for the delivery of raster image files. Telecommunications bulk transfer is possible; however, it is not the preferred method due to cost considerations. Future interactive access to the contractor's data base will present the option to access specific portions of the data as appropriate and, at that time, telecommunications may be a viable option for certain interim deliverables. An alternative may be to use interactive access to locate and order data that is subsequently delivered using physical media. The preferred physical media option to use at this time is magnetic tape. Reference the tape media standards discussed in Appendix D of this handbook.

50.3.2.3.4.1. **Decision #4 - magnetic tape.** Magnetic tape is the preferred physical medium for delivery. It is a mature, stable technology that is usually available at all sending and destination systems.

50.3.2.3.4.2. **Decision #4 - optical disk.** Optical disk will be a future alternate physical media due to emerging standards and the increasing number of DoD programs using optical disk technology. The major optical disk advantage is its ability to archive and store large volumes of data.

50.3.2.3.5. **Digital deliverable summary.** In general, the evaluation and selection of options at each decision node of the Engineering Drawings decision template must be aligned to the capabilities of the automated engineering data repository systems of the using Military Department. Raster image files should be acquired early in the life cycle of the program, when the principal application is review and approval. CAD data files could be the final deliverables of choice for drawings obtained for spares reprocurement technical data packages if the data were originally developed on CAD systems.

50.3.2.3.6. **Example - delivery of digital data to DoD engineering data repositories.** For example, the appropriate selection of options for engineering drawings delivered to the Army Digital Storage and Retrieval of Engineering Data System (DSREDS), the Air Force Engineering Data Computer Assisted Retrieval System (EDCARS), or the Navy/Defense Logistics Agency Engineering Data Management Information and Control System (EDMICS) should be as follows:

a. Raster image files delivered on magnetic tape in accordance with MIL-STD-1840 and MIL-R-28002 Type I.

b. CAD data files in IGES delivered on magnetic tape in accordance with MIL-STD-1840 and MIL-D-28000 Class II.

50.3.2.4. **Decision guidelines.** Digital deliverable options for engineering drawings are not mutually exclusive. There will often be cases when several options will be combined for specific deliverables during a weapon system acquisition.

50.3.2.4.1. **Intended data use.** To help evaluate the various option combinations, the following guidelines are provided:

a. Select raster image files for archiving and print-on-demand requirements.

b. Select IGES data files for subsequent input to government or industry CAD systems or to CIM systems for manufacture of spares.

50.3.2.4.2. **Life cycle phases.** To help evaluate the various option combinations, the following guidelines are provided:

a. Select raster image files for early phases with low volumes or frequent anticipated design changes, except when the drawings submitted for design approval are to undergo data processing analysis by the government.

b. Select raster image files in later phases if early phase engineering drawings were paper-based.

c. Select IGES data files in later phases if the data are to be input to CAD/CIM systems for modification or spares manufacture.

50.3.2.4.3. **Delivery cost.** To help evaluate the various option combinations, the following guideline is provided:

Select magnetic tape for delivery of large volumes of engineering drawing data.

50.3.2.4.4. **Available technology.** The following guideline applies:

Select IGES data files if the engineering drawings were created on contractor CAD systems.

50.3.2.5. **Contract implementation for digital data.** The prior discussion of nodes on the Decision Template for Engineering Drawings indicated that there were two basic, yet non-exclusive, digital deliverable alternatives, as listed in table III.

50.3.2.5.1. **Digital data deliverables.** For both alternatives in table III, DoD-STD-100 is insufficient to describe the

TABLE III. **Summary of engineering drawing forms and standards.**

Deliverable and Form	Preferred Delivery Mode	Implement With
1. Raster Image File	Magnetic Tape	MIL-R-28002 ref.by MIL-STD-1840
2. CAD Data File	Magnetic Tape	MIL-D-28000 ref.by MIL-STD-1840

appropriate methods to contractually invoke these alternatives. Therefore, the following changes to DoD-STD-100 have been submitted for review, coordination, and publication:

a. Add paragraphs 101.1.2; 101.1.4; 104.3; and 106.1.1 as follows:

101.1.2 Raster/Vector (SELECT RASTER FOR RASTER IMAGE FILE. SELECT VECTOR FOR CAD DATA FILE.) Drawing Format. The sheet layout, border, title block, revision block, and other conventions of engineering drawing format including definition and use of explicit scaling factors shall be integral to the raster/vector (REPEAT SELECTION AS ABOVE.) data file.

101.1.4 Layer or level conventions. The file layer or level conventions shall be identified for all data residing in the digital data file.

104.3 Raster/Vector (SELECT RASTER FOR RASTER IMAGE FILE. SELECT VECTOR FOR CAD DATA FILE.) Digital Data Originals. Raster/Vector (REPEAT SELECTION AS ABOVE.) digital data originals must be verified to ensure the validity of the data format contained in the data file.

106.1.1 Scale of digital data. The digital data base should represent an object or assembly at full scale to ensure the shareability of represented data. The visual or reproducible image should be at a scale appropriate for human understanding.

b. Add sentence to the end of paragraph 201.1.1, as follows:

Engineering drawings prepared by the use of a CAD system shall conform to figures 200-1 through 200-41, unless otherwise instructed by the contracting officer.

c. Add note to paragraph 502.1, as follows:

Note: Revisions made to the digital data base should accurately and precisely represent the change in dimensions to the geometry of the object or assembly to ensure the shareability of the represented data.

d. Add paragraph 503.7, as follows:

503.7 Identifying location of revisions on digital data images. All changes made to digital data bases must be identified explicitly on their visual output.

Pending publication, these additional requirements should be included in the statement of work, or in Block 16 of the CDRL (DD Form 1423) to specify delivery of digital data in accordance with MIL-STD-1840. The physical media standards for magnetic tape delivery mode (shown in Appendix D) should also be specified.

50.3.3. PRODUCT SPECIFICATIONS AND BOOK FORM DRAWINGS.

50.3.3.1. **Scope.** Product specifications and book form drawings provide information such as material content, manufacturing and treatment processes, inspection and testing procedures, performance requirements, etc, needed for the acquisition of the drawing item. This information is an essential element of the product definition data set. It is characterized by a mix of approximately equal amounts of graphics and supporting narrative text. Specifications and book form drawings applicable to an item are referenced on the engineering drawing of that item. Additionally, a referenced specification or book form drawing may itself reference related specifications and book form drawings, creating a hierarchy of referenced information, all of which are required to fully describe the item.

50.3.3.2. **Purpose.** This section identifies the options for delivery of product specifications and book form drawings. The options selected for delivery of specifications and book form drawings are not necessarily the same as for engineering drawings. However, these information products are usually created, processed, and used in conjunction with one another. Consequently, when selecting the delivery option for specifications and book form drawings, the delivery option for

the engineering drawings should be taken into consideration for technical data package (TDP) consistency.

50.3.3.3. **Decision option discussion.** Figure 6 shows the Master Decision Template for Acquisition of Digital Deliverables as applied to the specifications and book form drawing portion of a TDP. The alternatives presented, while not exclusive, must be considered and applied in context of the complete TDP and not the individual elements of a TDP.

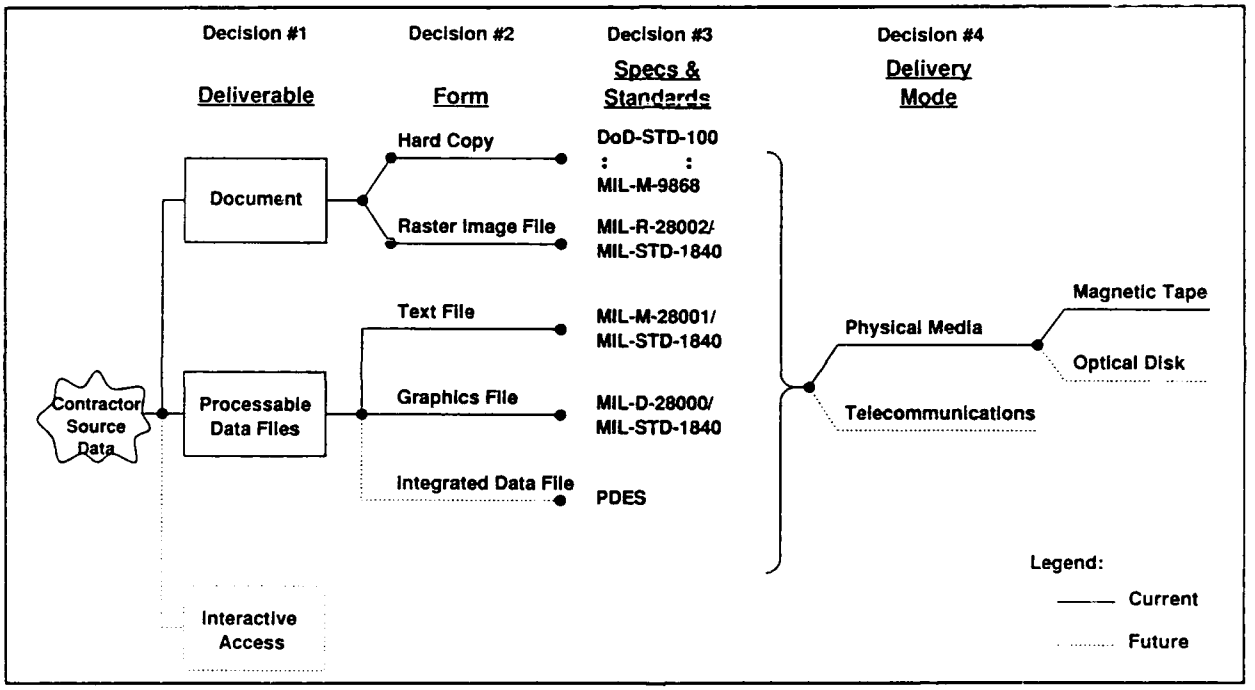

FIGURE 6. **Decision template for product specifications and book form drawings.**

50.3.3.3.1. **Deliverable options - decision #1.** The specifications and book form drawings portion of the TDP can be delivered as documents or as processable data files. Interactive access to engineering design data bases containing product specifications and book form drawings is a future goal. The document deliverable option offers the least flexibility, even when provided in digital form. Documents are static, formatted presentations of information which can only be archived, viewed, and printed after receipt. Processable data files, on the other hand, offer greater capabilities; these files can be updated or transformed into many different document types. Delivery of

specifications and book form drawings as processable text and CAD data files is both preferable and technically feasible. Source data can be created by electronic publishing systems (text) and CAD systems (graphics). However, the government data processing infrastructure to permit acceptance and utilization of the information in this form are not yet available in DoD. Therefore, the deliverable option for the specifications and book form drawings portion of the TDP is effectively limited to the document category at present.

50.3.3.3.2. **Form options - decision #2.** For documents, the options are either hard copy (paper or aperture cards), or digital raster images. While the hard copy option includes paper, the usual procedure is to deliver documents in the same aperture card form as for engineering drawings. The digital option is limited to raster image data because the PDL alternative has not been developed for specifications and book form drawings as it has been for technical manuals. As shown in figure 6, certain types of processable data files are technically feasible, although not yet available because of receiving system limitations. When implemented, these options will include delivery of product specifications and book form drawings as processable text and graphics files, and ultimately integrated data files containing both text and graphics. Delivery of a combination of raster image text and CAD data files is also technically feasible. However, this imposes an additional layer of processing complexity on the sending system, and is not considered a practical alternative.

50.3.3.3.3. **Specifications and standards option - decision #3.** Since the processable data file option cannot currently be supported by DoD receiving systems, the relevant standards for that option will not be discussed, although they are listed in figure 6. (See the discussion of specifications and standards for technical manuals and engineering drawings for additional information.) For deliverable documents, aperture cards are the predominant medium for capturing hard copy images of the specifications and book form drawings portion of a TDP. Specifications and standards governing hard copy preparation are DOD-STD-100, DOD-D-1000, MIL-STD-804, MIL-D-5480, MIL-M-38761, MIL-D-8510 and MIL-M-9868. MIL-R-28002 governs delivery of raster image files; the default form is Type I (untiled raster), with Type II (tiled raster) available to meet specific contract requirements. It is extremely unlikely that program needs would dictate a different raster type selection for specifications and book form drawings than is made for engineering drawings.

50.3.3.3.4. **Digital delivery mode options - decision #4.** The delivery mode for specifications and book form drawings as

documents (raster image files) may be either physical media or telecommunications. However, because of cost considerations, the delivery of raster image files using telecommunications bulk transfer conventions is not recommended. Of the physical media options shown at decision #4, magnetic tape is currently the preferred alternative. As with engineering drawings, optical disk provides a desirable future delivery mode option, although it is not yet widely available or standardized. See Appendix D of this handbook for the applicable tape media standards.

50.3.3.3.5. **Digital deliverable summary.** In general, the evaluation and selection of the options at each decision node of the specifications and book form drawings decision template must be aligned to the capabilities of the automated engineering data repository systems of the using Military Department. Selections should be consistent with those made for engineering drawings unless there is a specific reason for making different choices.

50.3.3.4. **Decision guidelines.** In general, the options selected for delivery of specifications and book form drawings in digital form are closely tied to the options selected for the associated engineering drawings in the TDP. As with the drawings, it is likely that no single option may apply to all specifications and book form drawings data. Finally, the delivery options selected for the specifications and book form drawings portion of the TDP must be compatible with the receiving system capabilities. The following guidelines are provided to assist in the option selection process.

50.3.3.4.1. **Intended data use.** The following general guideline is provided:

> Select raster image files for archiving and print on demand requirements.

50.3.3.4.2. **Delivery cost.** The following general guideline is provided:

> Select magnetic tape delivery for delivery of large volumes of specifications and book form drawings.

50.3.3.4.3. **Available technology.** The following general guideline is provided:

> Select raster image files until destination system technology allows delivery of specifications and book form drawings as processable data files.

50.3.4. OTHER TDP COMPONENTS (RESERVED).

(This section will provide a decision template and supporting rationale for the acquisition in digital form of other elements of a technical data package. The CALS Industry Working Group on Spares Acquisition is defining those elements and the results will appear in a future update to this handbook.)

50.4. ACQUISITION OF LOGISTIC SUPPORT ANALYSIS RECORDS (LSAR).

50.4.1. **Scope.** This section addresses the acquisition alternatives of LSAR data. Logistic Support Analysis (LSA) builds upon data from related systems engineering and design analyses, and produces a consolidated and integrated set of logistics-related technical data. The resulting Logistic Support Analysis Record (LSAR) is a logically integrated data base consisting of both the engineering source data upon which analysis tasks are based, and the analysis results. With the exception of very small programs, documentation of the LSAR is accomplished using automated LSAR systems. MIL-STD-1388-2 defines the format and content of the LSAR and the structure of various standard reports that allow delivery of the data in digital form. It also defines LSAR system processing requirements and encourages additional LSAR system development.

50.4.1.1. **LSAR data elements.** MIL-STD-1388-2 defines the total set of data elements that could make up an LSAR data base. The acquisition manager must tailor application of the standard to weapon system program requirements by selecting the subset of data elements actually required. This is done by incorporating in the contract DD Forms 1949-1 and 1949-2 listing the specific LSAR data that the contractor must generate and provide (through access or delivery) to the government. Some data elements (such as LSA control numbers) are required because they are keys to the data base organization. However, few weapon system programs require all LSAR data elements.

50.4.1.2. **Joint service LSAR data system.** A baseline LSAR system, the Joint Service LSAR Automated Data Processing System, has been developed as one alternative for LSA automation. This batch mode, flat file system is capable of satisfying the requirements of MIL-STD-1388-2, but it lacks many desirable features and capabilities afforded by current technology. Many contractors have augmented the joint service system by adding front-end software to improve data entry efficiency. Others have used data base management software to make the data accessible to both on-line inquiries and various LSA software tools. Finally, some contractors have linked software tools for other

engineering, design, and Integrated Logistic Support (ILS) functions to the LSAR to use or update LSAR data. DoD is currently revising the Joint service LSAR data system to implement relational data base technology.

50.4.1.3. **Flexibility of the LSAR.** Because of the range of data that can be documented in an LSAR, the LSAR is able to satisfy the data requirements of a number of the deliverables commonly appearing on a Contract Data Requirements List (CDRL), such as Provisioning Lists and Failure Modes, Effects, and Criticality Analysis reports. When these deliverables are submitted to the government as processable data files, or when direct access to the data base is provided, improvements in data accuracy and integrity usually result. Since the LSAR is already a logically integrated data base, it invites the use of other software tools and linkage with related engineering data bases. Furthermore, cost and time savings in data review or receipt of deliverables can also be achieved. During the initial acquisition contract, the most cost effective means of LSAR data access or delivery should be evaluated to enable the contractor to offer as part of the subsequent phase proposal one or more digital means of data delivery or access.

50.4.1.4. **Relationship of standards for LSAR to other CALS standards.** Two functional standards govern LSA and the LSAR. MIL-STD-1388-1 defines the LSA process, as a result of which LSA data is created. MIL-STD-1388-2 defines the requirements for the LSAR, through which much of that data is assembled, managed, and reported. MIL-STD-1388-2 is also a technical standard for delivery of LSAR data in digital form. Because it serves as both a functional and a technical standard, it is unnecessary (and incorrect) to use MIL-STD-1840 to define requirements for delivery of LSAR data in digital form. Future revisions might separate MIL-STD-1388-2's functional standard role from its technical standard role, if such a separation appeared to serve a practical purpose. At this time, it does not appear that this would be the case.

50.4.2. **Decision option discussion.** The master Decision Template for Acquisition of Digital Deliverables as applied to the LSAR is displayed in figure 7.

50.4.2.1. **Deliverable options - decision #1.** LSAR data can be delivered as LSAR reports, LSAR data files, or through interactive access to a contractor LSA data base. All three options either encourage or require a contractor automated LSAR. The requirements for LSAR final deliverables will likely be a combination of at least two of these options.

50.4.2.1.1. **Deliverable options - decision #1 (for LSAR reports).** The LSAR reports option includes the reports identified in Appendix B of MIL-STD-1388-2, plus any contractually-required, project-unique reports that can be produced using LSAR data. Most reports allow refinement or focus for a specific user by tailoring or reformatting. Many of the reports were designed as analysis and data review tools and are not intended to be deliverable products. LSAR reports are static presentations of LSAR data and cannot be updated or processed further after delivery. They offer the least flexibility for LSAR data use. Therefore, requiring LSAR reports as a deliverable option is appropriate only for one-time deliveries or when no further processing capability is available.

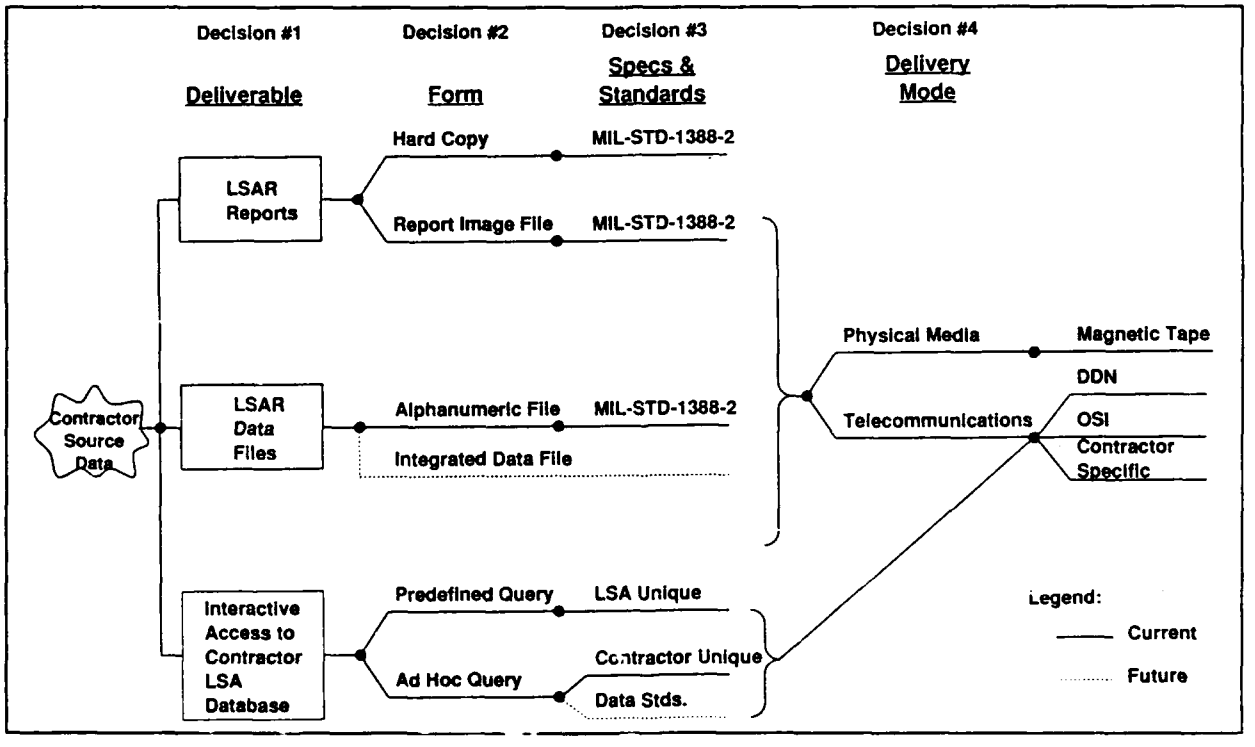

FIGURE 7. **Decision template for logistic support analysis records (LSAR).**

50.4.2.1.2. **Deliverable options - decision #1 (for LSAR data files).** LSAR data files, the second option, includes the three LSAR master files defined in MIL-STD-1388-2, and other LSAR data files that require processing after delivery (such as input files for Provisioning, Defense Logistics Services Center (DLSC) Screening, or Packaging Systems, among others). An internal data processing capability is required for each LSAR data file.

Delivery of the LSAR master files provides the capability to subsequently produce any of the LSAR reports and other data files that the LSAR data base was designed to support, and provides historical baseline data for weapon system/equipment. Separate delivery of other LSAR data files places responsibility for their generation with the contractor rather than the government. Because of the flexibility provided by these processable data files, they can be used to satisfy both interim and final LSAR delivery requirements. Periodic delivery can reduce time spent for on-site data reviews by providing a vehicle for advanced review of the data. Final contract deliverables can be consolidated and reduced by internal processing of LSAR data files, in part or in total.

50.4.2.1.3. **Deliverable options - decision #1 (for interactive access).** The third LSAR deliverable option is interactive access to a contractor's LSA data base. Interactive access includes the ability to selectively retrieve, review and print, and process contractor LSA source data. Interactive access for faster government review of LSAR information represents more of a contractor service capability than a specific deliverable requirement. This capability makes the most current authorized data available to the government and eliminates the time required for preparation and submission of deliverable products. It can also significantly reduce the time requirement for on-site reviews, while supporting internal analyses and planning that requires up-to-date supportability information. Interactive access provides the greatest flexibility for using LSAR data, either by utilizing the contractor's automated LSAR capabilities or by electronically transferring the data for further internal processing. Since interactive access can support interim and final delivery of both LSAR reports and data files, it may entirely eliminate the need to bring the LSAR data in-house. (However, it is advisable to have LSAR master files delivered at contract completion.) The interactive access service can be very effective for satisfying LSAR deliverable requirements during the early life cycle phases when the volume of LSAR is low. In latter phases, interactive access may be more appropriate as a contract compliance, data review, and internal analysis tool rather than for bulk transfers of complete LSAR master or other data files.

50.4.2.1.4. **Requirement for automated LSAR.** Regardless of which deliverable option is selected, statement of work language (SOW) requiring the contractor to establish an automated LSAR capability should be included in the LSA Program SOW. (See Contract Implementation for Digital Data for sample SOW's.)

50.4.2.1.5. **Use of multiple LSAR data sets.** Logistic support analysis is a dynamic, iterative process requiring real-time interaction between the design, engineering analysis and product support planning functions. By this means, logistics considerations are made an inherent part of the design process, not an after-the-fact consequence of design decisions that excluded support requirements. The requiring activity (the government) must identify what LSAR data is required, and the performing activity (the contractor) must decide how best to structure the CITIS in which that LSAR data is processed, stored, and made available to users while maintaining appropriate data protection and data integrity. These decisions must balance the requirement for continuous, real-time update of LSAR data that documents LSA tasks already performed and supports LSA tasks underway or yet to be performed, with the requirement to periodically baseline technical information about the product being designed. Such baselines are needed to support configuration management of the product and its technical data, and to meet contractual requirements. Cost is an important consideration in this decision -- the additional costs of maintaining and reconciling multiple LSAR data sets, against the additional costs that result from losing configuration control of the product or of information about the product. The concept of working data, submitted data, and approved data is one solution to this problem, but it may not always be the optimum solution. Contract SOW requirements such as those suggested here must be established with due consideration of these program management and cost considerations.

50.4.2.2. **Form option - decision #2.** Each of the three deliverable options for the LSAR provides one or more viable form options.

50.4.2.2.1. **Form option - decision #2 (for LSAR reports).** As shown at the top of figure 7, LSAR reports can be delivered either as hard copy reports or as a report image file. Hard copy reports include both computer-generated LSAR reports (Appendix B of MIL-STD-1388-2) and program-unique LSAR reports. Report image files, the digital equivalent of these reports, require no further data processing and can be loaded, viewed, and printed using standard system utilities. Both options are a fixed presentation of the LSAR data and the applicable DID's must be selected for the desired reports. If the hard copy form is selected, the DID hard copy option should be noted.

50.4.2.2.2. **Form option - decision #2 (for LSAR data files).** The single available form option, alphanumeric files, is discussed above. The use of an integrated data file is a future

option presently under development that will be addressed in the next update to this handbook.

50.4.2.2.3. **Form option - decision #2 (for interactive access).** As shown at the bottom of figure 7, interactive access to a contractor's LSA data base can take two forms: predefined queries or ad hoc queries. A predefined query is a established a fixed format, with a controlled set of options, to extract information from LSA source data. All of the LSAR reports including program-unique reports that are contractually required, as well as LSAR master files and data files, can be described as predefined in this context. With the format, content, and options already having been specified, the user selects the file or report (usually via a menu choice) to be displayed. On the other hand, ad hoc queries allow the aggregation and presentation of a contractor's LSAR source data to be defined by a user during an on-line session with the contractor's system. Ad hoc query capabilities are governed by the specific technologies and software of the contractor's system, and their availability will be controlled by the contract or other form of agreement. As CALS data standards for LSAR are developed, this limitation may be altered, as reflected by the dashed line for data standards at the bottom of figure 7. Until then, although the ad hoc query capability can be identified in the LSA SOW, it can only be defined by a contractor's proposal. Care should be exercised in evaluating contractor proposals to ensure that the proposed ad hoc query capability will satisfy government requirements.

50.4.2.3. **Specifications and standards - decision #3.** There are no decision options on the standards for LSAR reports or LSAR master data files. These files are all alphanumeric tabular data files as specified in MIL-STD-1388-2. Since report image files can be generated by a sending system so easily, the technically feasible alternative of raster image data adds an additional level of data processing complexity, and is not a practical alternative.

50.4.2.4. **Digital delivery mode options - decision #4.** As shown at the right of figure 7, there are two delivery mode options for LSAR report image files and for data files: physical media delivery or telecommunications transfer. Physical media consists of data delivery on magnetic tape, with the use of optical disk technology as a future alternative. Telecommunications involves the bulk electronic transfer of data files using network that is compatible with a specific telecommunications standard (DDN's TCP/IP, or OSI's GOSIP FIPS 146), or a public, or contractor-specific non-standard telecommunications network. If interactive access is not chosen for interim reviews, the most cost effective option for final delivery of LSAR reports and data files will

normally be magnetic tape. When an interactive access capability will be established, the cost and accessibility benefits of telecommunications versus physical media delivery modes must be evaluated. For physical media delivery, use existing or program-unique DID's and indicate the tape delivery option. Reference the tape media standards contained in Appendix D of this handbook. For telecommunications delivery of LSAR report image files or data files, the reports or data files to be electronically transferred should be included in the LSA program SOW.

50.4.2.4.1. **Interactive access.** For the interactive access service, the only deliverable mode option is telecommunications. Options for selection of a telecommunications standard and delivery network are listed at the end of the telecommunications branch in figure 8. The choice depends upon the volume of data to be transferred, as well as the technologies in place at contractor and government facilities.

50.4.2.4.2. **Queries.** If predefined queries are selected as the access form, the LSAR reports and files and the telecommunications standard should be included in the LSA program SOW. If ad hoc queries are chosen, the LSA program SOW must contain appropriate language without delineating specific report and data files. If both predefined and ad hoc queries are required, include this in the LSA program SOW and indicate the LSAR report and other files to be accessed. (See 50.4.4 for sample SOW paragraphs.)

50.4.3. **Decision guidelines.** Options for delivery of LSAR data in digital form are not mutually exclusive. There will often be cases when several options will be combined for specific deliverables during a weapon system acquisition. The decision criteria presented in this handbook focus on the best options, but must be evaluated against program-specific requirements. The guidance below applies the decision criteria to the various LSAR options.

50.4.3.1. **Intended data use.** The following guidelines apply:

a. Select LSAR data files for consolidation of deliverables.

b. Select LSAR data files if significant internal analysis of the data is anticipated.

c. Select LSAR data files for input to automated government receiving systems.

d. Select interactive access with predefined queries to review LSAR data.

e. Select interactive access with ad hoc queries to support unique analysis or delivery needs.

50.4.3.2. **Life cycle phases.** The following guidelines apply:

a. Select LSAR data files for later, high volume phases.

b. Select interactive access to replace early phase LSAR deliverables.

c. Select interactive access to support LSAR data reviews in all phases.

d. Select LSAR hard copy reports for early phases if low volumes of data in the current or later phases do not justify the cost of additional automated processing.

e. Select LSAR hard copy reports for nondevelopmental programs with limited service life data requirements.

50.4.3.3. **Delivery cost.** The following guidelines apply:

a. Select LSAR report image files if multiple report copies are required and the processing capabilities of government receiving system are limited.

b. Select LSAR data files, in general, as the most cost effective option for all deliverables.

c. Select interactive access to minimize on-site review requirements.

d. Select magnetic tape for delivery of high volumes of digital data.

50.4.3.4. **Available technology.** The following guidelines apply:

a. Select LSAR hard copy reports or interactive access if no internal data processing system capabilities are available.

b. Select LSAR report image files or interactive access if only limited internal data processing system capabilities are available.

c. Select LSAR data files for full scale development or production phases if internal data processing capabilities are available or planned for that time.

50.4.4. **Contract implementation for digital data.** Automation and telecommunications technologies, while providing extended capabilities to industry and government, are altering the ways in which LSA and LSAR reporting and use are performed. The prior discussion of decision choices on the LSAR decision template indicated that there were six basic, yet non-exclusive, alternatives for delivery of digital data. These alternatives require that specific procedures be established for LSAR configuration management, interactive access controls, government review and feedback, and product delivery. The alternatives associated with telecommunications assume that an interactive access capability exists for LSAR report files. When existing functional standards are insufficient to describe the appropriate methods to contractually invoke these alternatives, new SOW language must be provided. Each alternative has specific SOW phrases that should be included in the LSA program SOW. Sample SOW's are provided in the following text to implement the alternatives as summarized in table IV.

TABLE IV. **Summary of LSAR forms and standards.**

Deliverable and Form	Preferred Delivery Mode	Implement With
1. LSAR Report Files	Magnetic Tape	New SOW #1
2. LSAR Report Files	Telecommunications	New SOW's #1 & #2
3. LSAR Master & Data Files	Magnetic Tape	New SOW #1
4. LSAR Master & Data Files	Telecommunications	New SOW's #1 & #2
5. Interactive Predefined Query	Telecommunications	New SOW's #1 & #2
6. Interactive Ad Hoc Query	Telecommunications	New SOW's #1, #2, & #3

50.4.4.1. **Sample SOW language.** The following sample SOW's describe the contractor technology capabilities required by the

alternatives. These SOW's are cumulative based upon the combination of alternatives desired within the program.

a. SOW #1 is suggested for automated LSAR capability.

The contractor shall establish and maintain a validated LSAR automated data processing system capable of input, storage, and retrieval of LSAR data in accordance with MIL-STD-1388-2. The contractor may use an internally developed and validated LSAR automated data processing system, an independently developed and validated LSAR automated data processing system, or the government furnished Joint Service LSAR Automated Data Processing System. The validated LSAR automated data processing system shall comply with paragraph 4.2.2 of MIL-STD-1388-2 and shall be used for the preparation of LSAR output reports as specified in the CDRL.

b. SOW #2 is suggested for interactive access with predefined queries.

The contractor shall establish and maintain automated sets of LSAR data for the management and control of the LSAR. As a minimum, the contractor shall maintain a set of LSAR working data for in-process review and a set of government approved LSAR data. The LSAR data contained in the working (in-process review) set shall be LSAR that has been subjected to internal contractor review procedures and frozen, pending government review and approval. The LSAR working data shall be updated in accordance with the schedule in the LSA plan regardless of the approval status of their content since the last update. Upon government approval, LSAR data contained in the working set shall be transferred to the government-approved LSAR data set. All government-directed changes resulting from the LSAR review process shall be incorporated prior to relocation of the data. The government-approved LSAR data shall be cumulative of all government-approved LSAR data.

The contractor shall provide the government with interactive access to both the working and approved LSAR data sets. The contractor shall provide the means for controlling access capability. The interactive access capability shall include the ability to interrogate, retrieve, review, and print the following:

1. Predefined standard LSAR summaries using established standard LSAR report selection procedures contained in the applicable Data Item Descriptions.

2. Any of the following government specified reports: (SPECIFY CONTENT, FORMAT, AND SEQUENCE OF EACH REPORT)

The software will provide the capacity for terminal display of the specified queries or data files in 80 and/or 132 character format and will include the capability to print the results of the queries on a local printer at designated locations. The user shall have the capability to specify queries by data set. User options shall include generation of queries from the working data, the approved data, or a combination of both.

The contractor shall provide government with the interactive access capability ----------. (SPECIFY PERIODS OF REQUIRED ACCESS, i.e.,. 0800-1600 EASTERN STANDARD TIME DAILY, 24 HOUR CONTINUOUS, ETC.) Government use of the access capability shall be limited to ----------. (SPECIFY ACCESS USAGE REQUIREMENTS, i.e., IN CPU MINUTES/MONTH, TOTAL CONNECT TIME, ETC.) Access shall be limited to the following locations: (SPECIFY LOCATIONS)

The contractor shall establish telecommunications capability using one or more of the following methods and shall establish a means for ensuring completeness and accuracy of data transmissions.

1. Point-to-point dedicated lines,

2. A mutually acceptable commercial timesharing or packet switching network,

3. Telecommunications equipment and networks compatible with OSI using FIPS 146,

4. The Defense Data Network (DDN), or

5. Another mutually acceptable method as defined in the contractor's proposal.

In addition, the contractor shall provide:

1. The hardware for each of the designated locations (if required).

2. Maintenance for contractor furnished equipment and software (if required).

3. Training for --- (SPECIFY NUMBER) operators at each designated location.

4. --- (SPECIFY NUMBER) set(s) of automated data processing system operator manuals and user documentation per location.

c. SOW #3 suggested language for interactive access with ad hoc queries.

In addition to the predefined LSAR output reports, the contractor shall establish the capability for on-line ad hoc query (report generation). Ad hoc reporting capabilities shall be defined by the contractor's LSAR automated data processing system software and presented in the LSA portion of the contractor proposal. As a minimum, the ad hoc report generation shall be capable of keying on and displaying the following LSAR data elements: LSA Control Number (LCN), Alternate LSA Control Number Code (ALC), Part Number, Item Name, Task Frequency, Federal Supply Code for Manufacturers (FSCM), Quantity Per Assembly, Unit of Measure Price, (ADD ADDITIONAL DATA ELEMENTS AS REQUIRED TO THIS LIST).

50.5. ACQUISITION OF TRAINING PRODUCTS.

50.5.1. **Scope.** This section provides guidance in determining training products to be delivered to the government in digital form, and describes appropriate acquisition alternatives. Many but not all training products are suitable candidates for digital development, delivery, and application. Many training products contain a combination of textual narrative and illustrative graphic images presented in a formal, structured, page-oriented format, which allows use of the same technologies and CITIS capabilities as are used for preparation and delivery of technical manuals. The guidance in this section assumes that the Instructional Systems Development (ISD) process described in MIL-T-29053 and the ISD deliverables identified in MIL-STD-1379D (DRAFT) or similar service-specific functional standards will be used to determine the appropriate form and format of training products to be delivered.

50.5.1.1. **Training products and media.** Training products are used to train military personnel in the safe and effective operation and maintenance of weapon systems and equipment. They contain a composite of textual narrative and illustrative graphic images presented in a variety of media which are determined by program-specific training needs. Each of these products and media has particular attributes which make it an appropriate training solution to a particular set of training needs. Although training products can be developed in a variety of forms, they are all presented via a finite set of training media.

Each of these training media could be contracted for and delivered in a standardized digital format with varying degrees of ease and usefulness. The media used to present instructional products can be grouped into the following media categories:

50.5.1.1.1. **Instructor-based training.** Instructor-based training includes any form of training which utilizes an instructor, monitor, resource person, lab assistant, etc. Most of the training products which support instructor-based training could easily be contracted for and delivered as digital data. These products include instructor lesson plans, paper-based supplementary products, student workbooks, copies of visual training aids, performance evaluation tools, and job aids.

50.5.1.1.2. **Paper-based (page-oriented) training.** The paper-based training category includes training that is conducted primarily by some form of paper-based material. Paper-based training products are page-oriented products in that information is organized and presented via a page. Paper-based training usually includes the use of self-paced or instructor lead workbooks, tutorials, or job aids. Also included in paper-based training products are reference guides such as technical manuals and system documentation. (These are addressed separately in this handbook.) A significant percentage of all training products currently developed are paper-based. Paper-based products and training products could easily be contracted for and delivered as digital data in much the same way as technical manuals.

50.5.1.1.3. **Computer-based training.** Computer-based training refers to training which is delivered via a computer. Computer-based training includes tutorials, drill and practice, simulations, testing, and may also include embedded training. Computer-based training programs are already delivered in digital form to the government. However, they are currently delivered in a variety of formats and on a variety of magnetic media.

50.5.1.1.4. **Video-based and audio-based training.** Video media includes video tape or film training packages, interactive video-tape training, and interactive video disc training. Audio-based training includes cassette tape programs, instructional records, training extension course tapes, and audio-workbooks. Audio-based training is often supplemented by paper-based training such as job aids or workbooks and visual-based training products such as slides. Current technology would not allow for video-based training programs to easily be delivered in a digital format. Delivery of audio-based training programs in digital form is quite feasible. Whether or not it is cost effective and

useful to require audio-based training programs to be delivered in digital format is undetermined.

50.5.1.2. **Training products development.** DoD has developed the ISD methodology as a standard approach for the development of all contractor produced training programs throughout the military. ISD is a highly structured methodology which calls for the development of standard interim products, such as reports and plans, and ongoing government review. This highly structured methodology lends itself to delivery of products in digital form for government review and approval before the contractor moves to the next step in the development process. For the purposes of simplicity, this appendix addresses deliverables set forth in MIL-STD-1379D (DRAFT). However, the guidance provided in this document also applies to other service-specific training development guidance documents.

50.5.1.2.1. **Interim products.** The standard interim products that result from the ISD methodology typically include paper-based, page-oriented products such as training programs and training equipment plans; manpower, personnel, and training reports, personnel performance profile reports, media selection and syllabus reports; and course, module, and lesson objectives, etc. Additional products which may be developed in either paper-based or digital form include course, module, lesson flowcharts, tests, storyboards, and visual or video media shotsheets. The ISD methodology specifies that the government must review and approve each interim product before the contractor moves to the next step of the development process.

50.5.1.3. **Data sources for training products.** The Logistic Support Analysis Record (LSAR) consolidates logistics-oriented technical information in conjunction with data for the various engineering disciplines and Integrated Logistic Support elements to reduce redundancy, facilitate timely usage, and enhance consistency between data elements and disciplines. The quality and productivity of training product development is enhanced when the LSAR is used as a principal data source for this process. Integration of the data bases that produce LSAR task analysis (and other) data, technical manuals, and training materials will provide even greater benefits.

50.5.1.4. **Coverage.** This section only addresses the delivery in digital form of page-oriented training products. Requiring all training products to be delivered in a standard digital form would probably not be cost effective at this time.

50.5.2. **Decision option discussion.** Figure 8 shows the decision template applied to page-oriented training product deliverables.

Decisions regarding whether training products should be delivered in digital form and the specifications for that form should be consistent with decisions made for other contract deliverables such as technical manuals. The following sections describe the decisions to be made in determining the form and appropriate specifications for training product deliverables.

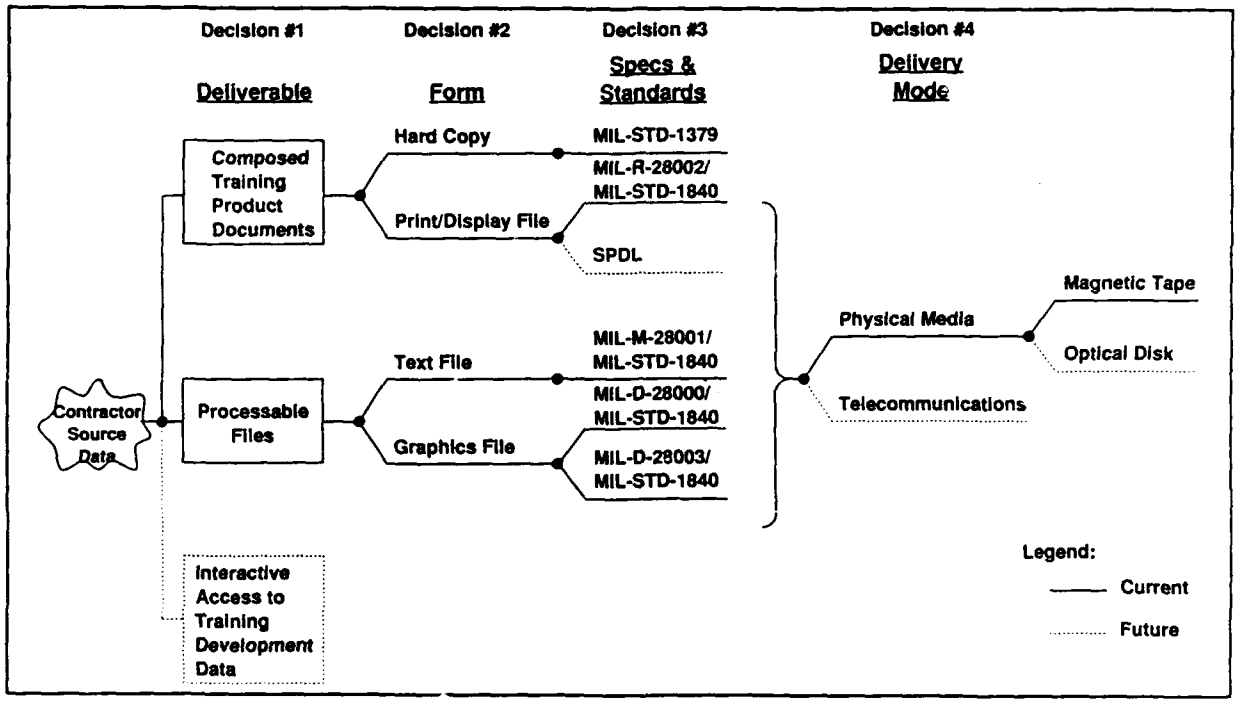

FIGURE 8. **Decision template for training products.**

50.5.2.1. **Deliverable options - decision #1.** Training products can be delivered as either composed documents, or as processable data files. The use of interactive access is a future goal, largely because of the absence of integrated data bases of training data in sending systems. As these CITIS capabilities are established and merged with technical manual authoring systems, interactive access will become a practical alternative for review and approval of interim training products.

50.5.2.1.1. **Deliverable options - decision #1 (for composed training product documents).** The composed document deliverable option offers the least flexibility. It is a static, formatted presentation of the material which can only be archived, viewed, or printed after receipt. Documents can be delivered as either camera-ready hard copy, or as a digital print/display file.

50.5.2.1.2. **Deliverable options - decision #1 (for processable files).** Processable training product data file deliverables offer more robust capabilities than document form deliverables. These files can be updated or transformed into many different document types. With the appropriate governmental receiving systems, processable files can support the development of summary guides, training aids, and eventual on-line distribution of selected portions of the data to trainees. Processable files are preferable because of their flexibility and maintainability; however the tools to permit acceptance and utilization of the information in this form are in various stages of development at this time.

50.5.2.2. **Form options - decision #2.**

50.5.2.2.1. **Form options - decision #2 (for composed training product documents).** The form for composed training product document delivery can be either a hard copy or a digital print/display file. The digital form of this deliverable consists of composed page images of material. It offers greater advantages in storage, distribution, viewing, and printing than hard copy. It also provides slightly more flexibility than hard copy with respect to future data uses, although its format will be fixed and unyielding. It is a two-dimensional image of each page, offering no further updating or processing features beyond replication. When changes are made, however, they can be more easily distributed than paper-based changes.

50.5.2.2.2. **Form options - decision #2 (for processable data files).** At present, a processable file must comprise one set of files for textual or numeric data and separate files for graphics, i.e., illustrations and drawings. In the future, text and graphics files will be available as integrated data files with configuration management and positioning features. The technologies and standards to accomplish such integration and to allow joint processing or creation of the two data formats for concurrent presentation, however, are not yet sufficiently advanced.

50.5.2.3. **Specifications and standards - decision #3.**

50.5.2.3.1. **Specifications and standards - decision #3 (for hard copy).** Currently each deliverable form, with the exception of the processable files graphic file form, has one predetermined standard and specification. The hard copy form should be acquired in compliance with MIL-STD-1379D (DRAFT).

50.5.2.3.2. **Specifications and standards - decision #3 (for print/display files).** The digital form of the composed training

product document, a print/display file, requires tailoring MIL-STD-1379D (DRAFT) by referencing the appropriate standards shown in 50.5.4. This data can also be delivered as raster page images, in accordance with MIL-R-28002. For most applications, the default Type I (untiled) format is applicable. Storage of page images in a Page Description Language (PDL) provides an intermediate form which is slightly easier to maintain. PDL files can be acquired using MIL-M-28001. However, these are not standardized, for no Standard Page Description Language (SPDL) exists yet.

50.5.2.3.3. **Specifications and standards - decision #3 (for processable files).** Processable training product files comprise separate text and graphics files. There is only one available text file standard, MIL-M-28001 (SGML), but users must require creation and delivery of appropriate document type definition and output specification support files, as well as the SGML-tagged source file. There are several standards available for graphics files. As with technical manuals, a mixed mode deliverable, consisting of processable text in accordance with MIL-M-28001 and raster document image files in accordance with MIL-R-28002 is a viable option. Raster format is often an attractive, cost-effective alternative for converting existing paper-based drawings and illustrations into digital form. Because they offer more flexibility and utility, and may be created and used on a greater variety of computer systems, vector graphics are preferred for new weapon system acquisitions. Use of CGM is preferred, but IGES is allowed. MIL-D-28003 addresses CGM vector graphics data; based on program requirements for interim and final training product deliverables, the acquisition manager should choose between draft quality Level II and publication quality Level I CGM conforming metafiles. MIL-D-28000 addresses vector graphics in IGES format; the Class I technical illustration subset is most appropriate.

50.5.2.4. **Digital delivery mode - decision #4.** As shown on the decision template, physical media are currently the only delivery mode option for the digital delivery of document image files or processable files. While a telecommunications bulk transfer of these files may be possible, it is not currently a feasible option because of the large volume of data contained in these files, particularly the raster page image and raster graphics files. Magnetic tape is currently the only physical media option available for the delivery of print/display files or processable files. Optical disk will become a future alternative physical media standard. For magnetic tape standards, reference the tape media standards contained in Appendix D of this handbook.

50.5.3. **Decision guidelines.** Options for delivery of training products in digital form are not mutually exclusive. There will often be cases when several options will be combined for specific deliverables during a weapon system acquisition. The decision criteria presented in this Handbook can be used to help make the decisions on the decision template. The following is guidance for applying the criteria to training products.

50.5.3.1. **Intended data use.** The following guidelines are provided:

a. Select processable files if government update and maintenance is anticipated for the future.

b. Select processable files if the future creation of specialized documents and aids is envisioned.

c. Select raster image files if only an automated print-on-demand capability is desired or available.

d. Select vector graphics files if update and maintenance of illustrations and drawings is desired.

50.5.3.2. **Life cycle phases.** The following guidelines are provided:

a. Raster image or print/display files should be acquired early in the life cycle of the program if most cost effective.

b. Processable training product files should be the deliverable of choice when the government assumes the responsibility for training manual update and maintenance.

c. Select static page-oriented documents if a program is in a late phase and large amounts of data already exist in paper form.

50.5.3.3. **Delivery cost.** The following guideline is provided:

Select magnetic tape for delivery because of the high volumes of digital data required by training products.

50.5.3.4. **Available technology.** The following guidelines are provided:

a. Options should be aligned to the automated publishing systems/computer resources in the Military Department receiving the deliverable.

b. Select hard copy if no internal data processing system capabilities are available or planned.

c. Select raster print/display files if only minimal data processing capabilities are available internally.

50.5.4. **Contract implementation for digital data.** There are five basic, yet nonexclusive, alternatives for delivery of digital data. These are shown in table V. The existing functional standard is insufficient to contractually invoke these alternatives. Therefore, tailoring of MIL-STD-1379 is required.

TABLE V. **Summary of training products forms and standards.**

Deliverable and Form	Preferred Delivery Mode	Implement With
1. Training Product/ Print Display	Magnetic Tape	MIL-R-28002 or Mil-M-28001 (PDL only), and MIL-STD-1840
2. Processable Text File	Magnetic Tape	MIL-M-28001 and MIL-STD-1840
3. Processable Vector Graphics File - IGES	Magnetic Tape	MIL-D-28000 and MIL-STD-1840
4. Processable Vector Graphics File - CGM	Magnetic Tape	MIL-D-28003 and MIL-STD-1840

50.5.4.1. **Training functional standard.** Following its publication, reference the tailored MIL-STD-1379D in Block 16 of the CDRL (DD Form 1423) to specify delivery of digital data in accordance with its requirements and MIL-STD-1840. Pending publication of MIL-STD-1379D (draft), make its language part of the statement of work. The physical media standards for magnetic tape delivery mode shown in Appendix D should also be specified.

50.6. ACQUISITION OF TECHNICAL SPECIFICATIONS AND REPORTS (RESERVED).

(This section will provide a decision template and supporting rationale for the acquisition of technical specifications,

reports, plans, and other contractual deliverables involving integrated text and graphics, e.g., those prepared in a desk top publishing environment. The National Institute of Standards and Technology is doing the work and the results will appear in a future update of this handbook.)

50.7. **ACQUISITION OF INTERACTIVE MAINTENANCE AIDS (RESERVED).**

(This section will provide a decision template and supporting rationale for the acquisition of interactive maintenance aids in digital form.)

APPENDIX C

FUNCTIONAL REQUIREMENTS FOR INTEGRATION OF CONTRACTOR PROCESSES

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10. SCOPE

10.1. **Applicability.** This appendix provides guidance to government activities on establishing contract requirements for functionally integrated contractor design and systems engineering processes on weapon system and major equipment development efforts. It is applicable to all Department of Defense (DoD) components which acquire weapon systems through the normal contracting process.

10.2. **Purpose.** This appendix is intended to suggest the best methods for tailoring the wording of standard DoD Requests for Proposal (RFP's) and Contract Deliverable Requirement Lists (CDRL's) to allow and encourage the integration of design engineering, systems engineering, and support engineering efforts and the digital exchange of data among them.

20. REFERENCED DOCUMENTS

See list of references appearing in Appendix A.

30. DEFINITIONS

See list of terms and acronyms appearing in Appendix A.

40. GENERAL GUIDANCE

40.1. **Contracting for integration of functional processes.** A major objective of CALS is the application of computer-aided methods and supporting technologies to incorporate logistic support functions as an integral element in the weapon system contractor's design process. To achieve this, the acquisition manager should apply the detailed requirements contained in section 50, tailored to fit the acquisition strategy selected for the program. These requirements specify the integration of design, manufacture, and support processes, as well as other elements of concurrent engineering, for the performance of DoD contracts. At a minimum, the general goals and objectives applicable to each identified functional area should be stated in industry informational briefings, commerce business daily listings, source solicitations, or instructions to RFP offerors. The full benefit to the program is realized only when the functional requirements are included in the RFP and the proposal evaluation/source selection process, and made contractually binding as described in section 50.

40.2. **Strategic approach.** As CALS evolves, weapon system technical data will be logically integrated into tightly coupled, controlled, and secure CITIS and government technical information system data bases, allowing access and authorized sharing of data at the data base level. Functional integration of contractor processes to ensure the security, currency, and accuracy of CITIS information will be articulated and contractually specified as CITIS requirements. CALS initiatives to improve technical data creation, management, and use provide an enabling environment that will accelerate the application of concurrent engineering, a systematic approach to creating a product design that considers all elements of the product life cycle from conception through disposal. In so doing, concurrent engineering simultaneously defines the product, its manufacturing processes, and all other required life cycle processes, such as logistic support. CALS functional requirements for concurrent engineering will provide the necessary focus for a comprehensive concurrent engineering strategy that addresses multiple approaches and the necessary enabling environment. Specific CALS thrusts, such as integration of R&M with CAD and CAE will directly contribute to application of concurrent engineering concepts.

40.3. **Application environment.** The earlier in the acquisition cycle that this strategy is introduced, the greater the potential productivity and quality improvements. As decisions affecting a product's design are made, both acquisition and operational support costs become defined. The earlier in a system's design

definition that the user's requirements can be addressed by the product design and associated manufacturing processes, the greater the opportunity to produce a more robust, supportable design at lower life cycle cost and greater operational effectiveness. This requires a change to the way most companies function. For example, new product designs historically have been the property of the company's engineering department. When design and engineering analyses are completed, the design passes to manufacturing, where necessary engineering changes are identified, beginning a costly iterative process resulting in the as-designed vs. as-manufactured configurations of the product. A CALS and concurrent engineering strategy must begin at Milestone 0 to produce the greatest returns in terms of development time, acquisition cost, life cycle support cost, and product reliability and maintainability.

40.4. **R&M integration with CAD/CAE.** The detailed requirements contained in section 50 are applicable to all engineering activities that define, establish, or influence reliability and maintainability (R&M) properties during all phases of item development, including concept exploration, demonstration and validation, full scale development, and production. The intent of section 50 is to influence the contractor to conduct engineering activities which have a bearing on the R&M properties of the ultimate fielded product, using computer aided design (CAD) and computer aided engineering (CAE) procedures that interact and actively share data with all other design engineering processes and procedures. Traceability of key design decisions having a major bearing on the R&M properties of the item to the engineering procedures, design criteria, and data bases that influenced the decisions is also a major goal.

40.5. **Integration of contractor LSA processes with R&M and design engineering.** (Reserved).

40.6. **Configuration management of technical data.** (Reserved)

40.7. **Concurrent engineering.** (Reserved)

50. DETAILED GUIDANCE

50.1. **Organization of guidance sections.** This section is organized into several major sub-sections, which can be used separately or together to contract for integration of contractor functional processes.

50.2. FUNCTIONAL REQUIREMENTS FOR R&M INTEGRATION WITH CAD/CAE

50.2.1. **Purpose.** This section provides guidance for the procuring activity in generating contractual requirements to achieve the integration of computer aided R&M engineering techniques with CAD and CAE in the development of weapon systems. It is applicable to all engineering activities that define, establish, or influence R&M properties during all stages of end item development, including concept exploration, demonstration and validation, full-scale development, and production.

50.2.2. **Impact of R&M.** R&M has a decisive influence on weapon systems acquired by DoD.

50.2.2.1. **R&M influence on effectiveness.** Weapon system R&M characteristics influence the weapon system's operational effectiveness by driving its readiness for battle, sustainability during battle, and utilization of personnel and material during training and battle. It is recognized that good R&M characteristics are force effectiveness multipliers by offering the means to defeat a numerically superior force by engaging it repeatedly. Reliable weapons systems result in increased combat capability while employing fewer fielded spare parts and less manpower. Similarly, maintainable systems require fielding of fewer people and specialized skill levels, while achieving reduced maintenance times. Good R&M characteristics improve the mobility of forces because there are fewer people and less support equipment and spares to move. In short, the R&M features of each weapon system contribute significantly to the conflict capabilities of forces at sea and in the field.

50.2.2.2. **R&M influence on life cycle cost.** The R&M characteristics of a weapon system are also key leverage points in determining the weapon system's total life cycle costs and operational effectiveness. An estimated 30 percent of life cycle costs can be traced directly to R&M characteristics of the weapon system's design. These costs occur not only as budgeted line items in the procurement and operations and maintenance appropriations for the particular weapon system, but also as indirect costs of the supporting logistics facilities and

activities, manpower, attrition replacements and replenishment spares.

50.2.2.3. **R&M in the design process.** While conventional stand-alone post-design R&M engineering tasks, such as test, analyze, and fix (TAAF), have been moderately successful in achieving improved R&M, these approaches are fundamentally limited by their inability to influence the design process itself. To a large extent, the R&M characteristics of a weapon system are attributes of its design, or more precisely, a direct function of the attention given to them in the design process. They are analyzed into the design after it has been completed only with great difficulty and cost. Additionally, the R&M improvement effort must compete with integration and operational testing for test resources and schedule.

50.2.2.4. **CAE in development.** The application of CAE resources to the R&M characteristics of weapon system development in an integrated design environment has the potential for effecting a quantum improvement in R&M. When applied to R&M design, CAE will provide the designer with closely-coupled, short-cycle analysis and feedback about the efficacy of the design approach so that corrective action and optimization can occur during the design process rather than later. In addition, concurrent design synthesis techniques offer a superior inherent R&M design capability. In essence, CAE enables the designer to design the product right the first time with respect to R&M, the objective of Total Quality Management (TQM).

50.2.3. **General implementation guidance.** The ultimate goal of integration of R&M into CAE is for all major design decisions affecting the R&M characteristics of the end item to be fully supported by automated procedures that are appropriate to the nature and level of the decision in a concurrent or near-concurrent fashion.

50.2.3.1. **Achieving the potential of CAE.** Achieving the full potential of integrated CAE requires capabilities in five fundamental areas:

a. Automated R&M analysis procedures tightly coupled to parts libraries and materials characteristics data bases.

b. Automated R&M synthesis processes based on design rules incorporating lessons learned from prior design experience and field use.

c. Fully characterized (tested and validated) component performance and R&M characteristics data bases.

d. Configuration management procedures that link major design decisions affecting the R&M characteristics of the end item to: (1) the CAE software and data bases used to develop decision criteria and otherwise support the decisions, and (2) the evolving configuration of the product, documented through configuration-controlled versions of the digital product description.

e. a supporting structure of hardware, software, and computer networks adequate to support the procedures and processes of (a) through (d) above and to closely couple R&M-specific resources (including personnel) with the rest of the design team.

50.2.3.2. **Contrast of traditional and integrated approaches.** Traditional R&M requirements take the form of independent tasks to be performed by the contractor as detailed in the contract Statement of Work (SOW), and in any R&M-related attachments and exhibits. The results of these tasks are to be delivered in accordance with the Contract Deliverable Requirements List (CDRL) in the format specified by a Data Item Description (DID). The integrated R&M functional requirement is different because it places an indirect requirement on the contractor's engineering resources, in the form of R&M-specific CAE techniques, procedures, and data bases. This indirect requirement necessitates a different contracting approach than does traditional R&M tasking, but is consistent with streamlining, and allows the contractor more freedom to determine how to satisfy the government's requirements. It replaces emphasis on specific SOW tasking with increased emphasis on the use of instructions to offerors and source selection criteria. This approach leads the contractor to tell the government how integrated R&M-specific CAE is to be applied to the program being bid, rather than telling the contractor how to apply it.

50.2.3.3. **Integrated procedure.** In essence, using this approach, the government will ask the contractor to describe their existing and proposed R&M automation capabilities; award the contract based, in part, on the strength of the response; make any necessary adjustments during final negotiations; and incorporate the results in the ensuing contract. No additional CDRL items or DID's are required. CDRL items and DID's normally invoked to acquire R&M data can be tailored in ways that encourage the contractor to develop automated means for the generation and submission in digital form of these data.

Suggested wording to implement tailoring is presented in 50.2.5.1.

50.2.4. **RFP and source selection guidance.** The following guidance is provided on contracting for integrated R&M data.

50.2.4.1. **Approach.**

50.2.4.1.1. **Instructions to offerors.** Section L (Instructions to Offerors) of the Request for Proposal (RFP) should require the contractor to:

a. Identify its capability and experience in the use of automated R&M functions.

b. Explain to what extent R&M design tasks are integrated with its CAE system.

c. Describe how specific CAE techniques, processes, and data bases will be used to satisfy R&M requirements.

d. Describe how R&M data bases will be used to support logistic support analysis and record generation.

50.2.4.1.2. **Evaluation criteria.** Section M (Evaluation Criteria) should be structured to emphasize these issues.

50.2.4.1.3. **Contractual Application.** The offeror's proposed capability should be made part of the final contract.

50.2.4.1.4. **Summary of benefits.** This process ensures that:

a. R&M CAE functions are user-driven and not just responses to government requirements.

b. R&M CAE is essential to winning contracts, and therefore will be given proper emphasis.

c. Specific R&M CAE capabilities will be used in the design and logistic support processes and will not be traded off or deleted because specific SOW requirements were not defined.

50.2.4.2. **Sample language.** The following subparagraphs contain sample language that is recommended for incorporation in Sections L and M of an RFP.

50.2.4.2.1. **Wording for Section L.** The following wording is suggested for incorporation in Section L of RFP's:

System Engineering: Computer Aided R&M Engineering Support

The offeror shall submit a description of the way in which Computer Aided Engineering (CAE) techniques and related resources are to be used to ensure that design decisions affecting the ultimate R&M properties of the system (item) are adequately supported by automated trade-off analysis, engineering simulation, or concurrent design synthesis processes. This shall include a general description of the CAE environment within which design and development is intended to take place, and a specific description of the CAE capabilities dedicated to R&M support. It shall also include a discussion of the offeror's formal procedures to verify and maintain the accuracy and effectiveness of these R&M CAE capabilities by validating the quality of the engineering functional capability performed, data base maintenance, and development of lessons learned design rules from all sources of feedback. This documentation shall constitute a major element of Part III - Engineering Specialty Integration, of the System Engineering Management Plan (SEMP). The offeror's internal format is acceptable for this documentation. The System Engineering Master Schedule (SEMS) shall describe the timeliness of these inputs relative to the overall system engineering program and other design activities.

The general description, including implementation status (current or proposed) of the CAE environment shall consist of the following:

1) CAE hardware resources available to the program, including percentage availability of shared resources.

2) CAE application programs available to the program, including source of commercial software, identification of proprietary software, and methods used to assure software quality.

3) Integration approach, including communications networking, data base sharing and management, and configuration control.

4) Policies, procedures, and organizational responsibility for control of CAE automation, specifically R&M automated tools.

5) Data standards and technical standards available for delivery of technical data to the government in digital form.

The specific description of R&M resources based within the CAE environment shall consist of the following:

1) An overview of the CAE resources, including hardware, software, and data bases to be applied to R&M.

2) The degree to which R&M tasks and functions, including testability and manufacturability tasks, are automated. As a minimum, all tasks imposed in accordance with MIL-STD-470, MIL-STD-785, and MIL-STD-2165 shall be classified into the following categories:

a. Not automated.

b. Stand alone, no direct access to the CAE design data base.

c. R&M algorithms reside within the CAE system, interfacing with the evolving resident item design when invoked.

d. R&M algorithms reside with the CAE system, responding automatically to all initial inputs, derived factors, and design changes where appropriate to support a design decision.

The offeror will receive credit in proposal evaluation for design-integrated R&M tasks and functions provided they are demonstrated to contribute to a coherent end-to-end R&M, CAE, or LSA engineering process.

3) Descriptions of the offeror's formalized procedure and past history of deriving 'lessons learned' from test results, field feedback, and vendor data, and translating them into design rules incorporated into the CAE system. This is not intended to be a repetition of the offeror's plan for a Failure Reporting, Analysis, and Corrective Action System (FRACAS) for the specific program. It shall be a description of how the offeror uses information from vendors, testing, and the field to improve both products, and design and manufacturing processes on an institutional basis, and how that process is intended to be applied to the program. The description should contain the process for confirming and assigning a level of confidence to the design rules; the controls over R&M design rules that are exercised

by the R&M organization; and the process by which tradeoffs between R&M design rules, cost, and equipment performance are accomplished.

4) A listing of the key design decision points influencing R&M in the proposed effort, the automated R&M functions that would be used to support them, and the relative time (with respect to major design reviews) of the decisions.

5) Description of data bases to support R&M characteristics of the features, components and materials applicable to the program (e.g. preferred parts list), including supporting information on source of data (vendor, company tests, government data bases, etc.); confidence factors reflecting both quantity of their source, and whether or not they are based on estimates, simulation, broad categories of parts, tabular data, or actual measurements; applicability to the program; specificity and level of detail; and applicability to reliability, maintainability, or diagnostics.

6) Description how product development configuration control procedures will be applied to R&M, including the capture of design decision criteria; discussion of the linkages between the design process and the R&M-specific CAE resources that were applied to it; discussion of traceability of design decisions to CAE resources, including software and data bases that supported them; and procedures in place to rapidly reassemble those resources to effect and record the impacts of an engineering change proposal with minimal impacts to the R&M characteristics of the system (item). State if this engineering history will be available to the government.

7) Description of the integration of R&M-specific resources with the other product development resources, including personnel, CAE communication networks, application software, and data bases.

8) The specific proposed wording for R&M CAD/CAE requirements to be imposed on all subcontractors of electronic subsystems, modules, assemblies, and custom components. The general criteria used to evaluate a subcontractor's responses to R&M CAE requirements relative to other criteria such as cost, schedule, and performance.

9) Description of the offeror's internal procedures through which the automated R&M functions including supporting data bases are demonstrated to be correct, including conformance to industry standards if applicable.

10) Description of the capability to deliver Failure Modes, Effects, and Criticality Analysis (FMECA); predictions; LSAR; failure summary reports; and other R&M reports appearing in the attached contract CDRL as digital data in government-approved standard formats.

50.2.4.2.1.1. **Wording if risk reduction is required.** If the Instructions to Offeror contain a requirement for a section describing a risk reduction effort, the following wording in addition to 50.2.4.2.1 is suggested:

The offeror shall identify the intended use of Computer Aided Engineering (CAE) techniques to aid in reliability and maintainability risk reduction, outlining the risks to be addressed, how CAE is intended to help reduce them, and the benefit of CAE over other approaches, including level of risk reduced, accuracy, or timeliness of results.

50.2.4.2.1.2. **Wording if preliminary design is required.** Where the Instructions to Offeror contain a requirement to provide preliminary design, system block diagram, functional partitioning of requirements, definition of configuration items, or preliminary system or item specifications, the following is intended to be added. The exact wording of the information requested from the offeror should be substituted for the phrase preliminary design.

It is critical that preliminary design data provided to the government by the offeror contain sufficient supplemental documentation so that the government can understand the design criteria used to support the preliminary design. Information documenting the CAE resources that supported major tradeoff decisions impacting R&M, including a description of the tradeoff decisions and a summary tracing the specific nature of the input to the decision from R&M, shall be provided.

50.2.4.3. **Sample language for Section M.** The following wording is suggested for incorporation in Section M, Evaluation Criteria, of RFP's:

The offeror's (technical/management/system engineering) plan will be evaluated for the extent of intended application of CAE. It is not adequate for evaluation purposes simply to cite the use of CAE on a blanket basis; i.e., CAE resources will be applied where applicable. The offeror must demonstrate their understanding of the use of CAE by including in a proposal a brief discussion of how CAE is to be applied to the R&M engineering process. The discussion should include

a specific summary of the CAE resources intended to be applied, the points in the development process where leverage from CAE is anticipated, any government required analysis that will be generated in whole or in part by CAE, and expected benefits to the program. The following specific criteria will be used:

1) What is the capability described by the offeror for direct concurrent or near-concurrent synthesis of the R&M characteristics of the design based on design rules, embedded design knowledge, feature-based design, or lessons learned files? What major R&M design decisions are so supported?

2) What processes does the offeror describe for conversion of lessons learned from the field or test processes to R&M design rules? Is there a formal process for creating, implementing, and validating new rules on the same CAE system/data base used to design the product?

3) Are adequate design analysis tools available to provide the information necessary for trade studies and for support of other data requirements (e.g., logistics)? Do these tools interact with relevant CAE design data base parameters as they evolve?

4) Are the R&M-specific CAE feature, component, and materials characteristics data bases (including failure properties, mechanical properties, and component models to support detailed engineering simulation of the product) adequate to support the design effort required? To what extent are they validated?

5) If the government plans to take over responsibility for sustaining engineering, to what extent will the offeror provide design decision traceability, including supporting data packages or data files? Are the interfaces between the contractor and the government, and between the contractor and any suppliers, adequate to support transportation of product data and models?

6) Does the offeror intend to employ sufficient CAE resources, including hardware, software, integration, and networking facilities, to adequately reduce risk and accomplish the proposed R&M program in a timely fashion?

50.2.5. **Contract requirements.** Contractor responses to Section L of the RFP should be used in final negotiations with the winning contractor. The object is to incorporate as contract

requirements all proposed items that the government and contractor believe will provide significant benefits to the design in terms of improved R&M performance. As contract requirements, the chance of R&M CAE functions being eliminated due to pressures from other program elements (e.g., costs, schedule) will be minimized.

50.2.5.1. **CDRL items.** No additional Contract Data Requirements List (CDRL) items are required as a result of R&M CAE implementation. While R&M CAE may reduce CDRL costs for some items, the specific CDRL requirements for each program should be based on specific government needs for design data.

50.2.5.2. **Tailoring.** In general, the CDRL lists the data to be delivered under the contract, frequency of submittal, generation procedures, and required formats. One method of motivating contractors to undertake R&M tool development and integration is to tailor the CDRL and the associated DID's. Selected tailoring can accomplish this goal by providing incentives for automated data item generation. A recommended tailoring approach for each of these elements is discussed below, followed by models of contract wording where appropriate.

50.2.5.2.1. **R&M task selection.** The availability of computer processable data must be considered when attempting to encourage the automation of any R&M task. The selection of the R&M tasks to be accomplished and the associated data items delivered are development phase dependent. This information can also be found in various military standards that describe the requirements for R&M programs. When an R&M task is required, the level of data expected to be available must be considered. For example, during the concept exploration phase, the Failure Modes, Effects, and Criticality Analysis (FMECA) can be performed to the functional level. The detailed level of digital data available during the full scale development phase, however, permits the accomplishment of the FMECA down to the device level. Where the offeror proposes to use CAE to support an R&M analysis task, the government program office can expect higher quality and timeliness in delivery of detailed data in a more useable form.

50.2.5.2.2. **CDRL/DID cross references: tailoring for digital format.** The CDRL will include a reference to the procedures required to perform the data item generation and to the desired format by referencing the Data Item Description (DID) to be used in Block 4 of DD Form 1423. During the phase-in period, the contractor can be encouraged to use automated data item generation capabilities by permitting data to be delivered in formats and standards that are not in conformance with CALS

directives. The following CDRL wording may be used in Block 4 of DD Form 1423:

> Block 4: If automated data item generation capability is used, contractor's format is acceptable.

50.2.5.2.3. **Tailoring: frequency of submissions.** In an effort to reduce the number of submissions required, one CALS objective is to establish government access to contractually approved portions of the contractor's CITIS data base. The program office should explore this option where applicable to reduce data delivery.

50.2.5.2.4. **Tailoring DID language.** The DID references the appropriate military standards and guidance to be used for data item generation, and includes formatting instructions. Generally, DID's are tailored to account for unique program aspects. Tailoring of the procedures and methods required for data item generation and the format of the deliverable can also encourage automation of the data item preparation task. The following wording is suggested:

> It is recommended that the contractor employ automated capabilities in the generation of the data items required. Modification of the submission format consistent with the level of automation proposed is acceptable. Submission of data in digital format is encouraged.

50.3. FUNCTIONAL REQUIREMENTS FOR INTEGRATION OF CONTRACTOR LSA PROCESSES WITH R&M AND DESIGN ENGINEERING.

50.3.1. **Purpose.** This section provides guidance for the procuring activity in generating contract requirements for integration of LSA and R&M engineering processes. These processes are often performed by separate contractor organizations, supported by separate automated sys'ems. Integration can reduce duplication of effort, improve the consistency and quality of data, and improve the quality of the system or item under development. The following statement of work (SOW) language is appropriate when the contractor has, or is expected to have, automated LSAR and R&M data systems.

50.3.2. **Suggested contract wording.** The following wording is suggested for incorporation in the SOW:

> The contractor shall identify in the LSA plan the procedures, either automated or manual, that will be used to ensure LSAR documentation requirements for reliability and

maintainability (R&M) information are satisfied through use of appropriate (R&M) data sources. The procedures shall describe how R&M source data are to be used in developing the LSAR, and shall address initial R&M inputs as well as change control for data additions, deletions and modifications. The procedures shall also identify the algorithms or transformations that must be applied to source data elements to conform to LSAR documentation requirements. The procedural description shall be of sufficient detail to clearly demonstrate traceability between the LSAR and individual R&M data sources, and the preservation of appropriate data flows while maintaining established LSAR data element relationships and interdependencies.

50.4. FUNCTIONAL REQUIREMENTS FOR CONFIGURATION MANAGEMENT OF TECHNICAL DATA. (RESERVED)

(This section will provide suggested SOW language for configuration management capabilities in government-owned, contractor-maintained data bases that support integrated functional processes. The CALS Industry Working Group on Configuration Management and Indexing is doing the work and the results will appear in a future update to this military handbook.)

50.5. FUNCTIONAL REQUIREMENTS FOR CONCURRENT ENGINEERING. (RESERVED)

(This section will provide suggested SOW language for application of a concurrent engineering strategy as part of the design and development process for weapon systems and major equipment items. The CALS Industry Working Group on Concurrent Engineering is doing the work and the results will appear in a future update to this military handbook.)

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APPENDIX D

CONTRACT REQUIREMENTS FOR DELIVERY MODES

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10. SCOPE

10.1. **Applicability.** This appendix provides guidance to government activities on the use of physical media and telecommunication networks for delivery of technical data in digital form, or digital access to technical information data bases. It is applicable to all Department of Defense (DoD) components which acquire weapon systems and related major equipment items, and their associated technical data.

10.2. **Purpose.** This appendix is intended to suggest the best methods for defining statement of work (SOW) requirements, and tailoring the wording of DoD Requests for Proposal (RFP's) and Contract Data Requirement Lists (CDRL's) to allow and encourage the integrated preparation and submission of, or access to, technical data in digital form.

20. REFERENCED DOCUMENTS

See list of references appearing in Appendix A.

30. DEFINITIONS

See the list of terms and acronyms appearing in Appendix A.

40. GENERAL GUIDANCE

40.1. **Access and delivery of digital data.** A major thrust of the Computer-aided Acquisition and Logistic Support (CALS) program is access to, and delivery of, weapon system technical data in digital form. This appendix provides guidance for contracting for the delivery alternatives discussed in Section 5 and Appendix B of this handbook.

50. DETAILED GUIDANCE

50.1. **Organization of guidance sections.** This appendix is organized into two major sections that address physical media and telecommunications alternatives for data delivery or access. These sections can be used separately or together to contract for technical data in digital form.

50.1.1. **Options.** The Decision Template for Acquisition of Digital Data reflects two options available for delivery of digital documents and processable data files, together with a single option for interactive access to CITIS data bases. The technology for both options has advantages for the user, and limitations on the ability to benefit from those advantages.

50.1.1.1. **Physical media.** Older types of physical media (i.e., magnetic tape) provide a mature, stable technology in which the user can place great confidence. Unfortunately, this media form is also slow, bulky, and cumbersome. Newer types of physical media (i.e., WORM optical disk and CD-ROM) hold great promise because of their much greater storage capability, but standard data formats are only now beginning to emerge, and interoperability remains a problem. Unlike magnetic tape, where system hardware investment is largely a sunk cost, use of WORM optical disk or CD-ROM may involve substantial investment costs.

50.1.1.2. **Telecommunications.** Secure, on-line transmission of the full volume of technical data for major weapon systems is technically feasible, but beyond the economical capability of current telecommunication networks in DoD and industry. In the near term, telecommunications will be limited to electronic mail exchange of high priority technical data, and interactive access where traffic volume is limited to queries, selective review and approval of data, or other clearly defined uses. In the longer term, cost effective and secure telecommunications capability will be essential for successful implementation of the IWSDB. Substantial amounts of government and industry research are underway to provide this capability. CALS is helping to define user requirements in this area. Development and implementation of DoD telecommunications capability is the responsibility of the Defense Communications Agency, under the policy guidance of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence. The National Institute of Standards and Technology can provide additional information on existing and planned commercial and government capabilities.

50.2. **Physical media.**

50.2.1. **Physical media options.** Physical media options include magnetic tape, magnetic disk, and several forms of optical media. Magnetic tape is the preferred physical medium for delivery of technical data in digital form because it is a mature, stable technology that is able to handle the large volumes of data typically involved in a major weapon system acquisition. Standards are well defined and usually well implemented, and little investment cost will be involved because almost all CITIS source systems and government destination systems provide magnetic tape read/write hardware. Magnetic disk is also widely implemented on personal computers and work stations, and may be the physical medium of choice for small business contractors. Several primary de facto magnetic disk formats are available, but no official standard has been accepted. Compatibility problems exist, but can be overcome with only moderate effort. Optical media is used here as a generic term to include CD-ROM (compact disk, read only memory), CDI and DVI (compact disk interactive and digital video interactive), WORM (write once and read many times), and erasable optical disk.

50.2.1.1. **Magnetic tape.** Magnetic tape includes three principal tape densities, only two of which are acceptable for delivery of technical data in digital form. The oldest is 800 characters per inch. Though still in use in many government and industry automated data processing systems, CALS government and industry users have decided that this is essentially obsolete technology, and is no longer an acceptable tape density for the large volumes of technical data that CALS data deliverables will typically encompass (see MIL-STD-1840). Instead, acceptable tape densities are 1600 and 6250 characters per inch, written on 9-track tapes in accordance with the Federal Information Processing Standards listed in MIL-STD-1840, paragraph 5.2.1. MIL-STD-1840 also includes specific instructions on single and multi-volume tapes, and data file organization. To acquire digital deliverables on magnetic tape, Block 16 of the CDRL (DD Form 1423) should be modified to incorporate the appropriate language from MIL-STD-1840.

50.2.1.2. **Magnetic disk.** The revolution that has changed 1970's mainframe computing to 1980's distributed, desktop computing has made magnetic disk a viable alternative for interchange of digital technical data. Although most large companies have implemented local area networks (LAN's) to interconnect individual users, magnetic disk (floppy disk and removable hard disk) remains a major medium for moving digital data among personal computers and work stations. For small business, where LAN's are not yet as widely implemented, magnetic disk remains

the dominant exchange medium. Magnetic disk may have only a limited role to play in delivery of technical data in digital form to the government, but it may have a major role in exchange of digital data among prime contractors and subcontractors. Most government destination systems are not prepared to receive digital data on magnetic disk, although jury rig solutions are not difficult. Acquisition managers should examine closely the role that magnetic disk could play as a digital delivery medium in specific program applications.

50.2.1.3. **Optical media.** For simplicity, the term optical media is used in this handbook to encompass several categories of physical media that have distinctly different physical and technical characteristics. Usually these categories are not lumped together, and computer specialists will draw major distinctions between each form. However, all these forms share one important characteristic: they are not yet ready for widespread use as a medium for digital delivery of technical data. Four categories are addressed in the following sections.

50.2.1.3.1. **CD-ROM.** DoD is conducting demonstrations and prototypes of CD-ROM technology for distribution of technical publications and other forms of technical data. CD-ROM disks are produced in a mastering studio, the investment cost of which remains significant. CD-ROM players are approaching the status of "standard option" on personal computers. However, data on a CD-ROM disk cannot be changed. The disk itself cannot be updated, only replaced.

50.2.1.3.2. **CDI and DVI.** This is a very new technology, which combines the capabilities of CD-ROM with video. It is still expensive because it has not yet left the research and development phase, and it has limitations on the amount of information it can communicate. CDI and DVI are competing approaches for providing a standard implementation of this technology. As the technology matures, and its cost declines, CDI will probably find its first application in digital training products.

50.2.1.3.3. **WORM.** This form of optical disk will be the first to be routinely used for delivery of digital data. It is the basis for DoD's automated engineering data repositories, and is being widely implemented by large contractors. (It is not as widely implemented as CD-ROM among smaller contractors and individual users.) Unlike CD-ROM, WORM optical disks can be updated at the user's work station. However, updating consists of writing a new file and file directory onto the disk. The old data is not replaced, so eventually an optical disk becomes full. To offset this disadvantage, the inability to erase or replace

data means that every configuration change is permanently documented. Current technology includes several WORM disk sizes. Twelve inch disks and the newer fourteen inch disks are primarily used for data storage by central repositories, and will be the medium for data delivery in only a few cases where (literally) huge volumes of data are being delivered. Five-and-a-quarter (5 1/4) inch disks will be used by DoD to exchange data between primary and secondary repositories, and will be a storage medium for digital technical data at desktop work stations. Even smaller disk sizes are now appearing. These are the disk sizes that will probably become the primary physical medium for data delivery in the near future. However, the investment cost for optical disk read/write hardware remains a barrier to implementation. Also, standards for physical formatting and logical formatting of optical disks are still being defined.

50.2.1.3.4. **Erasable optical disk.** This is another new technology, the routine application of which remains several years away. This category of optical disk can be both read and written at the individual work station, just as a magnetic disk is today. DoD and industry will implement this technology in the future, and most probably will eventually make it the principal physical medium for exchange of digital data. However, the technology itself is still emerging; standardization remains several years away.

50.3. **Telecommunications.**

50.3.1. **Telecommunication options.** In the current environment, the user of telecommunications for either data delivery or access has three options. The government and the contractor must work together to select the option that best fits user requirements and available capabilities.

50.3.1.1. **Contractor-specific networks.** The first option is use of an existing, oftentimes non-standard network already established by the contractor. The government, in effect, is hanging terminals onto the contractor's system, and becoming another node of the CITIS. In this case, the acquisition manager has the advantage of using an existing investment and a proven data architecture, and the disadvantage of being a captive audience. Nonetheless, this is a highly practical solution to an immediate requirement. Depending on the type of terminal and software used, and the procedures established for system and data protection and integrity (see Appendix E), processable data files can be downloaded onto physical media (e.g., a magnetic disk). The data are then available for additional processing and transformation under the control of the acquisition manager.

50.3.1.2. **TCP/IP-based DDN.** The second option is providing the contractor with an interface to the Defense Data Network (DDN). Because the DDN is a DoD network, sized to support defense requirements within available funding, the acquisition manager must provide sponsorship for defense contractor nodes, and must satisfy Defense Communications Agency requirements to justify and schedule connection to the network. The DDN is currently based on the Transmission Control Protocol and Internet Protocol (TCP/IP) standards which are widely supported in government and industry with many commercial, off-the-shelf products. However, DoD has committed to accompany industry in the transition to Open System Interconnection (OSI) compatible products, implemented through new standards such as the Government OSI Profile (GOSIP).

50.3.1.3. **OSI compatibility.** The third option for telecommunications is OSI compatibility, the telecommunications technology that industry as well as government is moving rapidly to implement. Unfortunately, OSI products won't be in widespread government use for several years, and R&D is still needed to address major issues such as data protection and integrity. Nonetheless, standards have already been established, and DoD has established a timetable for conversion from TCP/IP-based to OSI-based technology. As OSI-compatible DDN networks are established, the acquisition manager must meet Defense Communications Agency requirements to establish connectivity. However, implementation will be simplified because future industry telecommunications networks will also be OSI-compatible.

50.3.2. **DDN compatibility.** The DDN was developed in the 1960's to satisfy DoD telecommunication requirements. DoD helped pioneer this technology. Like most pioneers, DoD implemented systems from which later computer and telecommunication experts learned the improvements that would be needed to make widespread, standardized telecommunications technology more effective and more efficient. DoD will transition to the new OSI-compatible technology, but the legacy investment in TCP/IP-based technology means that this will not happen overnight.

Each DoD component has developed specific implementing technical language to accommodate its network-specific needs within a common DDN architecture. The following sections summarize (and generalize) that component-specific language. This information is not intended to substitute for component-specific technical requirements, but rather is intended to inform the acquisition manager of the general framework of capabilities that should be required. These generic requirements are for the current TCP/IP-based DDN only, and do not include requirements for migration to the OSI standards. They include DDN protocols up to and including the file transfer protocol, simple mail transfer

protocol, internet control message protocol, and TELNET. They do not address environmental considerations, performance requirements, training manuals, maintenance/warranty provisions, special security, installation, or network control.

50.3.2.1. **Interface with the DDN.** The contractor should provide the appropriate number of DDN interfaces for each host, node, or LAN. Long-haul or packet-oriented LAN communications capability will be provided by the DDN. The contractor should supply all required hardware, software, and accessory equipment necessary to achieve DDN operability for the proposed system. Each DDN interface node or host within the proposed configuration will be connected by the contractor to a DDN access circuit, which will be extended by the government to the site wherein the proposed system is installed. The contractor should provide the necessary cabling between the DDN access circuit terminus and the designated interface node or host.

50.3.2.1.1. **Data protection and integrity.** All hosts interfaced to DDN should be capable of being certified at an appropriate security level by an agreed upon date. Hardware, software, and procedures should be adequate to prevent misuse or abuse of both the system (computers and telecommunications) and data resident in the system (Appendix E).

50.3.2.1.2. **Topology.** If LAN topology is proposed, a gateway to DDN should serve as the interface device. Neither a LAN nor a gateway is required; only the DDN interface itself is a requirement. Another topology may be proposed. If a LAN is proposed that is packet-oriented, each designated DDN host on a particular LAN should have MIL-STD-1777/1778 installed for intra-LAN information transfer, along with internet control message protocol, MIL-STD-1780/1781/1782. If an Ethernet LAN is proposed, Request For Change 826 should provide address resolution between IP and LAN media access control. The Ethernet LAN will be IEEE 802.3 compliant.

50.3.2.1.3. **Gateways.** If a DDN LAN gateway is proposed, the contractor should provide the hardware and software necessary to serve as a DDN gateway between the proposed system and the DDN, and should interface the gateway to both the proposed system and the DDN packet switching node. The gateway should be implemented in contractor-provided equipment independent of the proposed system. The contractor should supply all appropriate gateway protocols to allow full communication between hosts and terminals on the proposed system and those on the DDN. The proposed system interfaces should provide transparent internetwork addressing and complete functional interconnectivity to the user. The gateway should be connected to the LAN, should support a minimum of 256

logical connections simultaneously, and should implement the channel access protocol for interfacing the gateway with the LAN. Hardware and software used to connect the gateway to the LAN should be provided. The connection to the LAN should support the minimum data transfer rate specified for the full-duplex gateway to DDN packet switching node interface.

50.3.2.1.4. **Interfaces.** The data link and network interface should comply with the DDN X.25 host interface specification. The physical interface should also comply with EIA RS-449, and should be capable of transmitting and receiving binary data at all of the following discrete data transmission rates: 4800, 9600, 19200, 50000, and 56000 bits per second. The electrical interface should comply with EIA RS-422-A and MIL-STD-188-114. The DDN exterior gateway protocol and all internet protocol (MIL-STD-1777 and supporting Defense Communications Agency interpretations) should be implemented in the gateway. The IP software should be able to automatically operate with receiving IP's that have not implemented identical IP options. Internet control messages should conform to the requirements of the internet control message protocol, and should be capable of receiving all message protocol message types.

50.3.2.2. **DDN protocols.** The contractor should provide the necessary protocol support to achieve the specified level of service interface with DDN. The network, TCP, and IP (as appropriate) protocols must be accessible by the user from higher layer services and user-developed code via service access protocols within each respective protocol in order to permit localized adaptations to the interface. Specific software procedures required to use the services of applicable protocols should be documented and made available to the government.

50.3.2.2.1. **Transport service.** For transport service, all TCP options specified in MIL-STD-1778 should be implemented, and all TCP systems parameters should be settable. The TCP software should be able to automatically operate with a receiving TCP that has not implemented identical TCP options.

50.3.2.2.2. **Application level protocols.** Terminal-to-host service should conform to MIL-STD-1782, including all DoD-approved TELNET options. All functions available to locally connected users should also be available to remote users at all locations following successful implementation of both system and application sign-on procedures. Some application functions may not have specific sign-on procedures. File transfer service should conform to MIL-STD-1780. At a minimum, ASCII and image data representations should be accepted. Electronic mail service should conform to MIL-STD-1781. In addition, an end-user mail

handler that utilizes the facilities of simple mail transfer protocol and the local file system should be provided, and should establish and maintain user mailboxes as required, and support appropriate mail host administrator functions. The end-user mail handler should automatically send or receive mail via MIL-STD-1781 ports, with logical-to-network address translation.

50.3.2.3. **Host-to-host front-end protocol interface (network and data link and physical layers).** The physical interface should conform to EIA RS-449 and MIL-STD-118-114. The interface should be capable of transmitting and receiving binary data at one or more of the following discrete data transmission rates: 4800, 9600, 19200, 50000, 56000, and 64000 bits per second. Data link, network interfaces, and service access for host-to-host front-end protocol communication should conform to the DDN host front-end protocol and service access protocols. The host front-end protocol link should conform to FED-STD-1041 (FIPS PUB 100-1). Two way simultaneous operation should be supported.

50.3.2.4. **Subscriber interface.** These requirements apply only to systems requiring Defense Communications Agency-approved interfaces. Government users who need unique, custom-designed DDN connections should define the specific characteristics of that interface following the DDN layered hierarchy description.

Examples of Standard DDN Protocols

Physical	RS-449, RS-232-C
Data Link	High-level data link control
Network	DDN X.25 (Standard)
Transport	TCP/IP
Session	Local
Presentation (and) Application	TELNET File Transfer Protocol, Simple Mail Transfer Protocol, Native Mode, Special User Applications as Required

50.3.2.5. **System-specific modification.** The protocols listed above are examples of a DDN standard configuration. Where special needs exist, they should complement, not replace, the basic DDN protocol structure. The system definition may require modification based on the unique needs of each acquisition, but the overall layered protocols used by DDN will be intact. Special, non-approved vendor protocols cannot substitute for listed DDN protocols. They must exist, if needed, outside the DDN domain.

50.3.3. **OSI compatibility.** The preferred future standard for telecommunications media access and delivery are protocols that provide Open System Interconnection (OSI) compatibility. OSI protocols have been developed by international standards organizations, primarily the International Organization for Standardization (ISO) and the Consultative Committee on International Telephone and Telegraph (CCITT). To provide OSI compatible networking capability for government users, a government OSI profile (GOSIP) has been published as a federal information processing standard. GOSIP defines the initial suite of protocols through which DoD and other government agencies will transition from current heterogeneous telecommunication systems to an OSI architecture.

50.3.3.1. **Origin of GOSIP.** GOSIP defines a common set of OSI data communication protocols which enable systems developed by different vendors to interoperate and enable the users of different applications on these systems to exchange information without use of physical media. GOSIP is based on agreements reached by vendors and users of computer networks participating in the National Institute of Standards and Technology's Workshop for Implementors of Open System Interconnection. To provide completeness, GOSIP is augmented with material from international standards and documents progressing toward international standard status.

50.3.3.2. **General application.** The GOSIP (FIPS 146) is effective as of February 25, 1989. For a period of eighteen months thereafter, until application of GOSIP becomes compulsory and binding, agencies are permitted to acquire alternative protocols that provide equivalent functionality. However, agencies are encouraged to use the standard for solicitation and contracts for new network products and services to be acquired after the effective date. For the indefinite future, agencies will be permitted to buy network products in addition to those specified by GOSIP and its successor documents. This includes other non-proprietary protocols, proprietary protocols, and OSI features and options not yet included in GOSIP.

50.3.3.3. **DoD application.** Waivers to FIPS may be granted under certain exceptional circumstances. However, DoD policy on the use of GOSIP was established even before the GOSIP FIPS was published. GOSIP was adopted in 1987 as an experimental co-standard to the TCP/IP protocols that provide similar services within the current structure of the Defense Data Network. GOSIP could be specified in addition to, in lieu of, or as an optional alternative to the DDN protocol standards. Now that the GOSIP FIPS has been formally published, it is a full DoD co-standard, and after the established transition period will become the sole

mandatory interoperable protocol suite. However, a capability for interoperation with the DDN protocols has been provided to ensure that existing systems can continue to function fully and effectively.

50.3.3.4. **Industry compatibility.** GOSIP is consistent with, and complementary to, industry's manufacturing automation protocol (MAP) and technical and office protocol (TOP). MAP/TOP addresses a broader range of functionality, and defines more advanced technology as a way to establish guidelines for future commercial product development.

50.3.3.5. **GOSIP implementation and extension.** GOSIP addresses the need of the federal government to move immediately to multi-vendor interconnectivity without sacrificing essential functionality already implemented in critical networking systems. All capabilities specified in GOSIP exist as standard products or are close enough to market that they can be proposed by vendors. OSI protocols providing additional functionality will be added to GOSIP as implementation specifications for those protocols are developed by the OSI Implementors Workshop. For each incremental extension to GOSIP, an eighteen month transition period will be applicable. Appendices to the GOSIP specification describe advanced requirements for which adequate profiles have not yet been developed.

50.3.3.6. **GOSIP functionality.** Currently, GOSIP addresses file transfer, access, and management (access and movement of information files among network users), and message handling systems (electronic mail or messaging between network users). GOSIP provides enough functionality to be generally useful for all government computer networking needs. If additional functionality is required to meet CALS technical data interchange and access needs, it can also be specified by the acquisition manager.

50.3.3.7. **Contracting for OSI delivery.** To require OSI/GOSIP compatibility as a delivery or access mode, FIPS PUB 146 should be cited. The GOSIP architecture supports a range of protocol choices at different protocol layers. A subset of these protocols may adequately satisfy an individual program requirement. If a subset of the GOSIP protocols and service interface profiles are chosen, it is the acquisition manager's responsibility to ensure that all paths through the architecture are complete.

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APPENDIX E

DATA PROTECTION AND INTEGRITY, DATA RIGHTS, AND RELATED ISSUES

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10. SCOPE

10.1. **Applicability.** This appendix provides guidance on data protection and integrity, data rights, change control, and related issues to government activities acquiring technical data in digital form or establishing CITIS functional integration requirements. It is applicable to all Department of Defense (DoD) components responsible for acquisition of weapon systems or related major equipment items.

10.2. **Purpose.** This appendix identifies issues that should be addressed by the acquisition manager, and suggests the best methods for tailoring the wording of standard DoD Requests for Proposal (RFP's) and Contract Data Requirement Lists (CDRL's) to allow and encourage the integrated preparation, government access to, and digital submission of deliverable data.

20. REFERENCED DOCUMENTS

See list of references appearing in Appendix A.

30. DEFINITIONS

See list of terms appearing in Appendix A.

40. GENERAL GUIDANCE

40.1. **Contracting for digital data.** A major thrust of the Computer-aided Acquisition and Logistic Support (CALS) program is the delivery of weapon system data in digital form. A second thrust is integration of the data bases which produce that data and make it available for use. Implementation of these objectives must be accomplished in a manner that protects from unauthorized access, use, or change: (1) information that is classified as having national security implications, (2) information that is contractor proprietary or competition sensitive, (3) information that is subject to export control as technologically sensitive, and (4) the systems that create, store, and distribute that information. Additional issues to be considered in contracts include data rights, privacy, and legal liability.

50. DETAILED GUIDANCE

50.1. **Data protection and integrity.** The goal of CALS data protection and integrity policy is to ensure the integrity and confidentiality of all CALS assets to the extent possible within existing regulations, procedures, etc. Inherent in the attainment of this goal is the requirement for adequate risk and data protection planning and implementation throughout the life cycle of weapon system technical data. The purpose of this section of the handbook is to aid acquisition managers in accomplishing system and data protection and integrity planning to ensure proper development, implementation, and administration for CALS programs and activities. This section of the handbook supports implementation of DoDD 5200.28, Security Requirements for Automated Information Systems. It is not intended as a substitute for the extensive specialized functional and technical guidance available on this subject.

50.1.1. **Background discussion.** The emergence of digital media has resulted in a new series of methods and techniques for unauthorized use and dissemination of information. The acquisition manager, other government users of technical data, and the contractor have a shared responsibility to provide an adequate level of protection in all CALS-related delivery and access modes. The level of protection must be commensurate with the level of information sensitivity. Providers and users of technical data should recognize that evolving technology and standards for system and data protection are being matched by evolving technology for protection infringement. The acquisition manager should address system and data protection and integrity requirements early and continuously throughout the life cycle of the weapon system. The program office security officer should be thoroughly familiar with CALS concepts for delivery of data in digital form, and for interactive access by government users to contractor data bases and by contractor users to government data bases. Using this knowledge, the program office security officer should play an active role in selection of the appropriate delivery or access modes. The contractor should be advised as early as possible of the security-related requirements for technical data to be delivered or accessed in accordance with CALS standards and statement of work provisions. The contractor should be required to thoroughly describe the procedures to be implemented at each level of sensitivity to protect technical data, and the systems and networks hosting that data, from unauthorized use or abuse.

50.1.2. **Systems approach to data protection and integrity.** Data protection and integrity requirements for CALS are divided into

six interrelated security disciplines: communications security, computer security, operations security, physical security, personnel security, and information security. These disciplines must be integrated into an overall systems approach.

50.1.3. **Government data protection and integrity issues.** Technical data generated in support of a weapon system acquisition program will include data that is unclassified, For Official Use Only (FOUO), subject to export control, corporate proprietary/source selection sensitive, or classified from a national security standpoint, (e.g., confidential, secret, top secret, etc.). Although the bulk of this data will usually be unclassified, the inferences which can be drawn from the accumulation of unclassified data (data aggregation) may dictate a higher level of classification for the data elements or the aggregate data. The delivery mode(s) selected for transmission of technical data to the government must provide a level of protection commensurate with the data's level of sensitivity. Multiple delivery modes may be specified in some cases. For example, a small classified appendix to an unclassified technical manual may be delivered in hard copy while the main body of the technical manual is delivered as a set of processable data files. For interactive access to weapon system data, provisions for access control and telecommunications security must be addressed in accordance with DoD and National Security Agency regulations and instructions. The procurement must clearly state what degree and levels of access will be required.

50.1.4. **Industry data protection and integrity issues.** In addition to providing protection for technical data commensurate with government-designated levels of sensitivity, industry must deal with company proprietary, competition-sensitive, or liability sensitivities of data. This is the responsibility of the contractor's facility even if government personnel have interactive access capability.

50.1.5. **Telecommunications.** The interrelationship and interdependency between telecommunications and computer systems are defined by Public Law 100-235, the Computer Security Act of 1987. Government agencies and systems security steering groups, including the National Security Agency and the National Institute of Standards and Technology, have been given the responsibility to establish policies, standards, products, and technical/research centers. Encryption of classified or sensitive military data should be in accordance with procedures established by the National Security Agency. Encryption of other sensitive data should be by commercial practice commensurate with level of sensitivity.

50.1.6. **Computer security levels.** Information processing products are evaluated to determine the level of their capability to protect information from unauthorized access. This evaluation is performed in accordance with the requirements set forth in DoD 5200.28-STD, The DoD Trusted Computer Systems Evaluation Criteria. One of the levels of information security is broadly categorized as system high. An information system that is operating at system high requires that all users with physical access to that system have a current security clearance equivalent to, or greater than, the highest classification level of any data resident on that system. A second level of information security is categorized as multilevel security. Multilevel security offers more advantages than system high to users who must deal with technical data whose elements are at different levels of classification or sensitivity. However, implementing an approved multilevel security system may pose major problems. An information system that incorporates multilevel security allows system access to users who have security clearances that are at a lower level than some of the data resident on the system. A multilevel security system must therefore protect information from unauthorized disclosure to individuals who have a lower security clearance, but who are authorized to access the system. All options and alternatives to multilevel security, including multiple physically isolated data bases, must be considered.

50.1.7. **Data protection and integrity requirements.** Technical data generated, processed, and disseminated in a computer aided and telecommunications environment must be protected in accordance with applicable statutes, regulations, and guidelines. Some data will be classified, and its protection is defined by law, executive order, and directive. Most data will be unclassified, but its protection is still necessary for the suppliers and users of the data. System and data administrators must also plan for disaster recovery; although this issue is unrelated to system/data compromise, the problems associated with restoration of data of known integrity are comparable. Survivability of both technical data and the weapon systems supported by that data will require the application of data protection and integrity measures for information, hardware, software and operating systems, and weapon system components. Life cycle data protection and integrity modeling will be used as:

a. A framework for analyzing all aspects of CALS data protection and integrity.

b. A basis for establishing data protection policies, plans, and procedures.

50.1.7.1. **Industry.** Appropriate data protection measures and standards are required when proprietary or technologically sensitive acquisition and logistics data are created, changed, transmitted, received, and stored in digital form. Effective industry application depends in part on the degree of control needed to meet data protection requirements, and the quality of the implementation and enforcement of those controls. To obtain early visibility and management of data protection and integrity issues, a risk assessment and security plan should be developed in response to anticipated weapon system program requirements as part of the offeror's proposal in response to an acquisition RFP. This plan should address levels of data protection for each access mode, and procedures for protection of classified data, with particular attention to interactive data base access and telecommunications.

50.1.7.2. **Government.** Since CALS technologies allow dissemination and use of industry-developed data beyond the control of the owner of the data, government access and control of this contractor information must be managed through the use of DoD-wide uniform standards. Data protection and integrity requirements will increase significantly as CALS encompasses more classified and sensitive information, and employs more automated systems to originate, communicate, and receive data. It is the responsibility of the program office to conduct a security risk analysis to identify anticipated data protection requirements as described in table 6.

50.1.7.3. **Risk approval procedures.** Risk approval procedures should be established to ensure the acquisition manager is provided with information on risk, trade off, and cost/benefit analyses that is adequate to make an informed decision concerning optimal data protection and integrity procedures. Risk approval procedures are based on the recognition that achieving perfect data protection and integrity (i.e., the absence of all vulnerabilities) is not usually feasible. The goal of the risk approval process is to provide the weapon system program with the best security practicable, at acceptable cost, consistent with other critical program parameters.

50.1.8. **Considerations for implementation of data protection and integrity.** System security engineering principles, as outlined in MIL-STD-1785, will be utilized to integrate data protection and integrity disciplines in an effective and efficient manner to achieve assured service, integrity, and confidentiality. Data protection and integrity programs will be developed on the basis of formal risk versus vulnerability assessment procedures.

TABLE VI. Identification of security by data item.

SECURITY CLASSIFICATIONS	
* DoD REQUIREMENTS	**LEVELS OF SECURITY CONTROL**
TOP SECRET	System level currently for
SECRET	classified information
CONFIDENTIAL	Transaction level currently for
FOR OFFICIAL USE ONLY (FOUO)	sensitive unclassified data
MOSAIC	Data element level in future
EXPORT CONTROL	CALS systems
* INDUSTRY REQUIREMENTS	**USER PROFILES**
COMPETITION SENSITIVE	Access & Control (for example)
COPYRIGHTED	by domestic company
TECHNOLOGICALLY SENSITIVE	by foreign company
COST SENSITIVE	by department
MOSAIC (applies to industry as well as DoD data)	by project by group
Procedures and software rules for access control user profiles, which becomes a matrix matching the data security level with the user profiles.	

50.1.8.1. **Industry.** In the transition from hard copy to CALS data interfacing and data integration technologies, the requirements for the protection of proprietary information will increase in sophistication and cost in proportion to the increased level of access control required. Access control issues exist at contractor/government sending and receiving sites, and in the telecommunication links connecting them. Data protection and integrity standards should be established and enforced early in the program in accordance with a CALS technical data security plan approved by the government program office. Access controls should be established in accordance with this plan.

50.1.8.2. **Government.** Information and communication-computer data protection and integrity management for CALS technical data must be addressed in accordance with DoD 5200.1-R, Information Security Program Regulation, and DoDD 5200.28, Security Requirements for Automated Data Processing Systems. The process for establishing data protection and integrity requirements is as follows:

a. Establish data protection and integrity requirements using CSC-STD-004-85, Guidance for Applying the Department of Defense Trusted Computer System Evaluation Criteria in Specific Environments. For a given maximum data sensitivity and minimum clearance or authorization of a system user, a computer security category, ranging from C1 to A1, is required.

b. Use DoD-5200.28-STD, the DoD Trusted Computer System Evaluation Criteria as a source for information processing product evaluation. The Evaluated Products for Trusted Computer Systems (called the Evaluated Products List) is contained in the Products and Services list that is prepared and published quarterly by the National Computer Security Center.

c. After definition of information and communication-computer data protection and integrity requirements by DoD weapon system and data system acquisition managers and by security managers, requirements should be passed to contractors using DD Form 254, DoD Contract Security Classification Specifications.

50.1.9. **Implementation guidance.** The acquisition manager should develop a program plan that incorporates a multi-disciplinary systems approach to meeting the data protection and integrity requirements of the program. This plan will identify responsible personnel and resources, and require government or contractor performance of:

a. Data protection and integrity threat and vulnerability analyses.

b. Data protection and integrity risk assessments and trade-off analyses.

c. Data protection and integrity test and evaluation.

d. Configuration control for security systems and trusted system components.

e. Identification of vulnerabilities that remain after implementing all reasonable security measures.

f. Periodic inspections to ensure compliance.

50.1.9.1. **Program Office Security Officer.** Information and communication-computer data protection and integrity requirements must be addressed early and continuously throughout the life of

the weapon system. Oftentimes, the most easily compromised information is that which is considered too fluid, too preliminary, and too incomplete to warrant serious data protection. The program office security officer should completely familiarize himself with CALS digital information delivery objectives and related data protection and integrity issues, as described in this appendix and in other DoD instructions relating to protection of classified and otherwise sensitive data. The program office security officer should fully participate in all decisions concerning access or delivery modes and media for technical data in digital form. These decisions should be made in a manner which is consistent with the CALS objective for the program, and which provide an appropriate level of protection at reasonable cost. In conjunction with other program office personnel involved in setting requirements for delivery of technical data, the program office security officer should determine the anticipated data protection and integrity requirements for the program, including volume of data anticipated to be delivered or accessed at each level. The security plans proposed by the various offerors, and the security plans and facilities available at government activities which will receive and process technical information, should be reviewed and taken into account in recommending the appropriate method of delivery or access.

50.1.9.2. **Contract implementation.** Determination of data protection and integrity requirements for technical information to be delivered or accessed, such as anticipated classification levels for technical manuals, engineering drawings, and other technical data, should be accomplished early in the program. Early dissemination of this information to potential contractors should be accomplished prior to award of contract, either as part of the bidder's briefing or in the RFP. This description should go beyond the scope of the DD Form 254, and should provide the contractor with a sufficient level of detail to develop a contractor data protection and integrity plan. The RFP should request a description of the offeror's proposed method for implementing data protection and integrity procedures for the protection of both classified information and information that the offeror anticipates being proprietary or sensitive from an export standpoint. The plan should be used by the government to plan and acquire the resources needed to receive, store, and process sensitive technical data at government facilities involved in the life cycle support of the weapon system.

50.1.9.3. **Suggested instructions to offeror language.** The following language is suggested for inclusion in instructions to offerors:

The offeror shall develop a preliminary plan which addresses intended data protection and integrity provisions for technical data to be developed and maintained by the contractor, and delivered to the government or accessed by government personnel. This plan shall be derived from the anticipated program data protection and integrity requirements provided by the government. It shall address levels and methods of data protection for all levels of technical data from the viewpoints of economy, impact on other program contract activities and schedule, and government plans for interactive access. It shall describe requirements (such as number and type of data encoding devices) to accomplish the data protection and integrity provisions contained therein. It shall be complete enough that the government can assess offeror's potential for compliance with data protection and integrity requirements while meeting the CALS objectives.

50.1.9.4. **Suggested statement of work (SOW) language.** The following language is suggested for incorporation in SOW's for classified data:

The contractor shall minimize the volume of information requiring specialized handling for purposes of data protection and integrity, and shall provide information at the lowest classification level practicable. For example, unclassified technical manuals are preferred over classified manuals, provided they contain adequate information to perform the function described therein. Largely unclassified technical manuals with a classified appendix or supplement are preferred over largely classified technical manuals. In organizing technical information in this manner, the contractor shall pay particular attention to items of information which by themselves are unclassified, but when taken together, allow classified information to be inferred. The government shall retain the right to conduct announced and unannounced inspections by security specialists at any time to review, audit, and account for classified materials.

50.2. **Data rights, privacy, and legal liability.** (CALS related work in the area of data rights, privacy, and legal liability is being performed by the CALS Acquisition Task Group. Supplemental guidance will appear in the FY '89 update to this handbook.)

50.2.1. **Application of CALS standards.** Application of CALS standards must be analyzed to ensure that adequate management procedures are implemented to control access to data that may require controlled distribution for reasons other than the data's

security classification. Access and distribution may be controlled because of any of the following:

a. Sensitive technology as indicated by documents or computer files marked or annotated in accordance with DoD 5230.24, Distribution Statements on Technical Documents, and controlled in accordance with DoD 5230.25, Withholding of Unclassified Technical Data from Public Disclosure. Refer to the relevant Service, Agency, or Command office, or, in accordance with Service or Command procedures, to the Office of the Deputy Undersecretary of Defense for Research and Technology.

b. Rights in technical data. Refer to Defense FAR Supplement Part 27.4 and the basic data rights clause at 52.227-7013.

50.2.2. **Liability and warranty.** Liability and warranty issues must also be addressed. Liability is often confused with ownership, but is a more precise concept. It is possible to own a computer program, such as a word processing application, without having the right to copy it, nor responsibility, nor liability for its proper use. Adequate control of changes and determination of change authority is also a critical legal issue. These issues are conceptually the same in a CALS environment as in the current paper-based environment. However, the application of CALS technologies provides both an opportunity to better address these issues, and the potential for additional abuse. It is the responsibility of the acquisition manager, in coordination with supporting DoD legal counsel, to establish, implement, and enforce procedures and safeguards to preclude the opportunity for such abuse. The contractor shares a responsibility to develop, implement, and enforce corresponding procedures and safeguards.

50.2.3. **Information change management and configuration control.** The selection of digital standards also requires review of manual and automated procedures for controlling and tracking data changes. Generally, the more functional utility provided by a data interchange or access standard, the more sophisticated and extensive must be the procedures for configuration management of the technical data. The ability to manage, control, and identify changes and change authority is absolutely necessary to proper assignment of liability and responsibility.

Custodians:
Army - CR
Navy - SH
Air Force - 24
DLA - DH

Review activities:
Army - AM
Air Force - 01, 02
NSA - NS
DCA - DC
NSA - NA
Other - NBS, DOE, GPO, NCS

User activities:
OSD - IR
Army - AL,AT,AV,CR,EA,ER,GL,ME,MI,MR,SM,TE,TM
Navy - AS,EC,OS,SA,YD
Air Force - 11,13,14,17,18,19,68,79,99

Preparing Activity
OSD-CL
(PROJECT ILSS-0035)

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-HDBK-59	DOD COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT(CALS) PROGRAM

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
	☐ USER
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

DD FORM 82 MAR 1426

PREVIOUS EDITION IS OBSOLETE.

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NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document*(s)* or to amend contractual requirements.

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OASD (P&L) WSIG
The Pentagon, Rm. 2B322
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